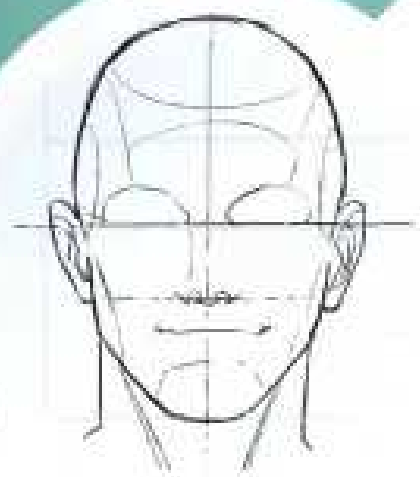


Drawing an archetypal figure

2D male

Part 01 | Basic form and proportions

By Laura Braga

Comic artist and illustrator

Human anatomy is one of the most complex things to depict, but is also one of the most important areas to get right for the success of a project. From correct anatomy comes not only the credibility of a character but also the ability to convey their mood. We accomplish this through gestures, posture, and movements of the character. For this reason correct representation of human anatomy is essential to creating a successful work of art.

This chapter will explain the rules to help us understand how to depict the male body. We will start by breaking human anatomy down into basic proportions using simple forms and lines. We will not examine and illustrate a detailed medical study of anatomy, but rather a set of simple rules that will help us to represent the functional nature of the human body, specifically applicable to the realm of artistic illustration and 3D animation.

We will study the anatomy of the adult male body, with a standard physical shape – it will therefore be a classic, idealistic model. Obviously not all human bodies reflect this kind of physical presence, but this model is definitely the most suitable and usable to start studying this topic.

After studying the general proportions of the human body, we will then move to the construction of the body as a whole.

PROTIP

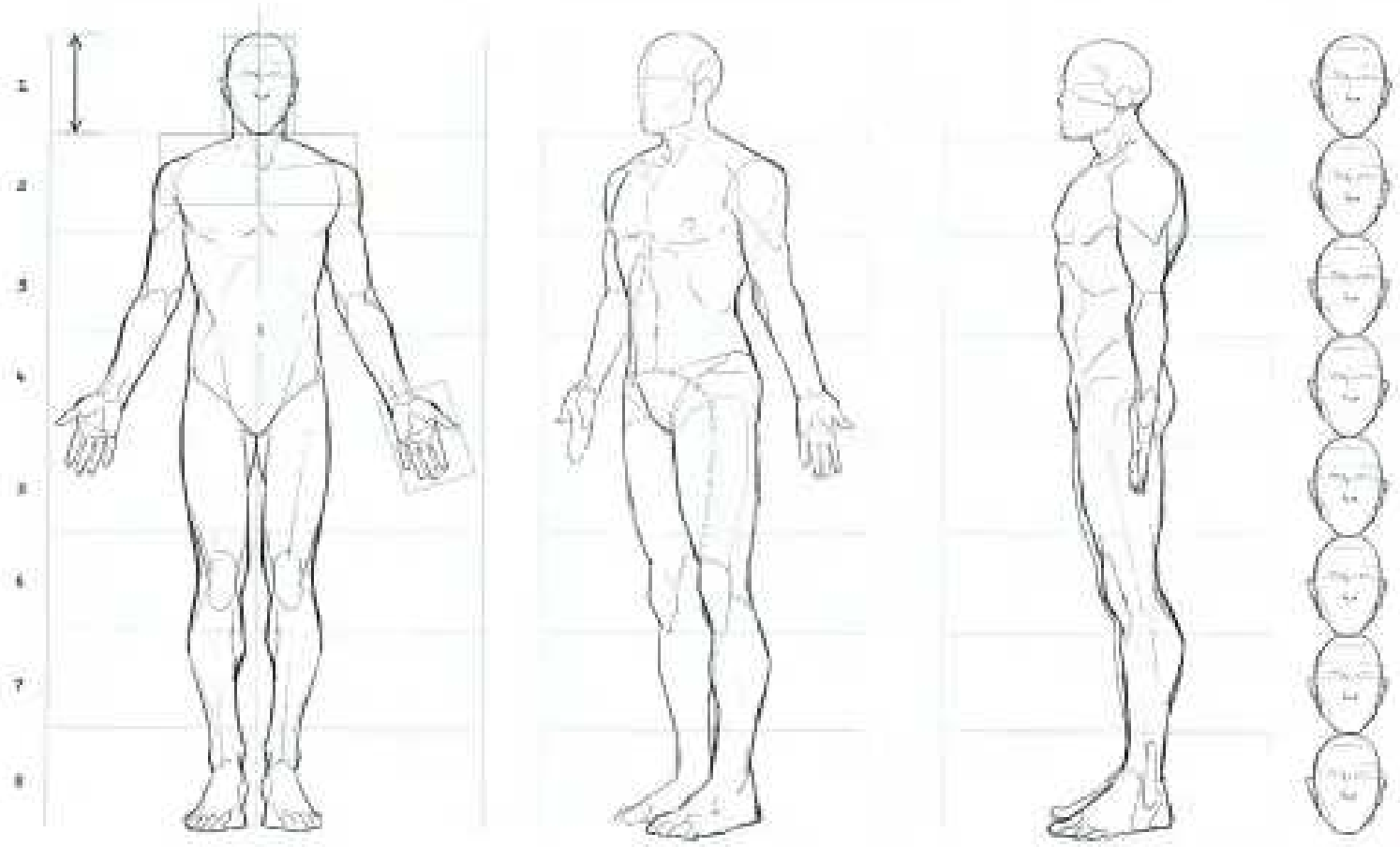
Don't just copy the lines

Don't just reproduce the correct forms; try to understand why and how the forms of the human body work in a certain way.

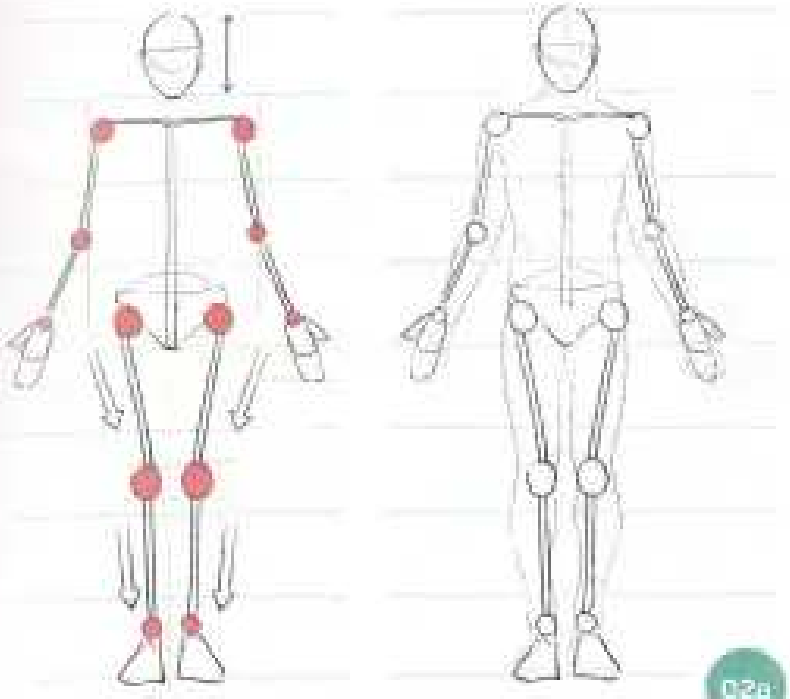
01: Proportions of the human body

To ensure we have the correct proportions for male anatomy, we can refer to simple standard schemes that illustrators use on a regular basis. These are as follows:

- the ideal height of the human body is eight times the height of the head;

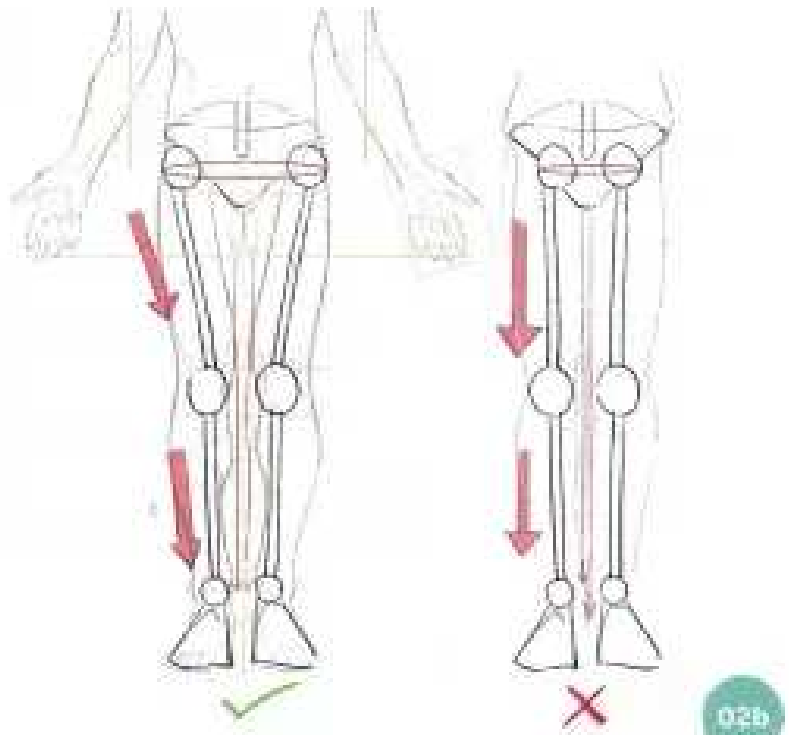


▲ Front, 3/4, and profile views of the male form



02a

▲ A rough line mannequin with joints highlighted



02b

▲ The legs have a subtle change from hips to thigh to calf

- the width of the shoulders is equal to twice the height of the head;

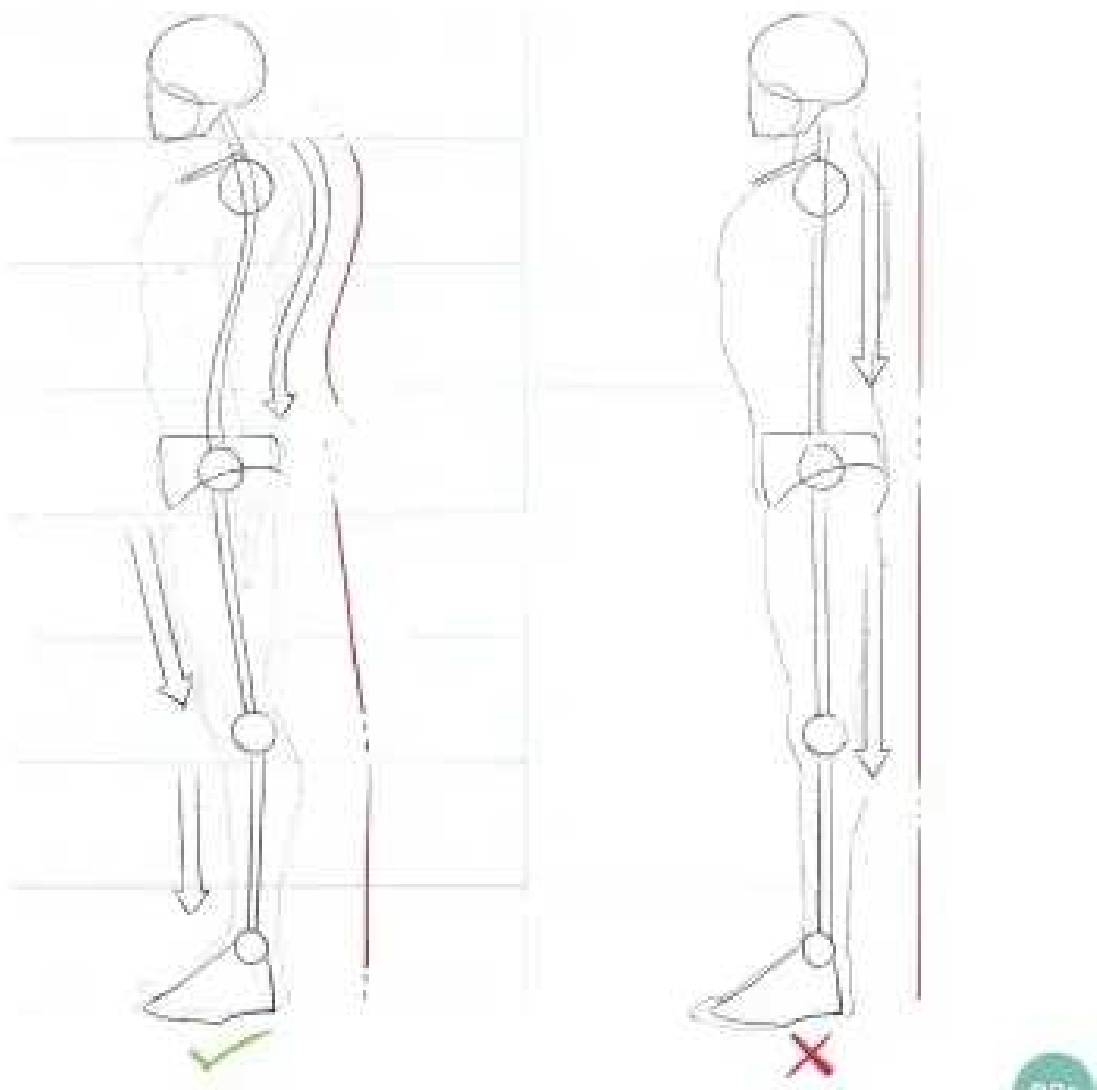
- the length of the hand is equal to the height of the head.

It is apparent that the height of the head is used as a consistent measure for the proportions of the human body. When rotating a model to represent him from other angles (3/4, profile, and rear), we must also keep in mind that it is critical that the proportions remain the same.

"Building the human body with a rough line mannequin allows us to quickly see whether we are using the right proportions"

02: Basic line references

Keep these proportions in mind as you build the figure. It is useful to draw horizontal lines as a base for your image in order to show the segments of proportions that we have referred to so far.



02c

▲ The S-curve of the spine

Building the human body with a rough line mannequin allows us to quickly see whether we are using the right proportions for the body, and judge if any proportions need to be fixed. This shouldn't take too long. Mark the joints with circles (fig.02a).

We can also build the legs at this stage, starting from the base. Note that the lines that define the legs (thigh and calf) will not be perfectly vertical to the rest of the body, but slightly oblique (fig.02b). Remember to keep the pose supple rather than rigid. Even when standing up straight the body is made up of gentle curves, not hard angular lines. The spine is important to get right because it is the main support column of the human form and conveys a natural look to the figure; it is not straight from the side but has a gentle S-curve (fig.02c).

"When rotating the model, remember that the spine will not be straight as depicted in the frontal view, but will instead form an S-shape"

03: Using solid shapes – front and 3/4 view

In order to simplify the anatomy of our model, we will begin to build the entire male human body using only cylinders and spheres. Place the spheres in the joints and in the head; for the rest of the body use cylinders (fig.03a).

It is important to use the correct cylindrical shape and orientation when drawing the individual parts; drawing an imaginary line down the middle of each can help to check orientation and placement. At first we will use simple cylinders and then look at the right shapes and volumes later.

It will be easier for us to understand and represent the body seen from the front than from a 3/4 view, but it is good practice to study all the positions and rotate our model a full 360 degrees to better understand all forms of human anatomy.

When rotating the model, remember that the spine will not be straight as depicted in the frontal view, but will instead form an S-shape (fig.03b). This shape gives the correct posture and allows the body to stay erect. Remember though that the male body is not as curved as the female body (fig.03c).

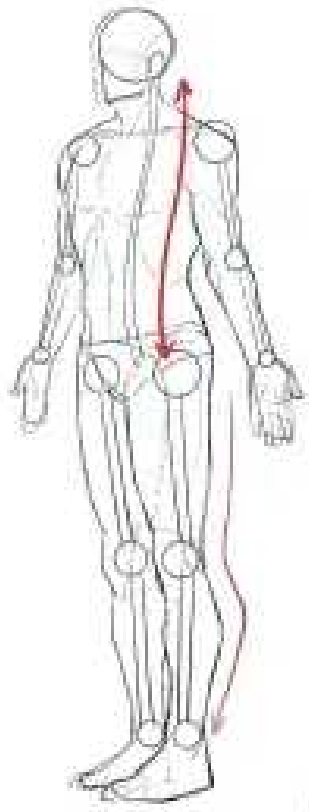
A good trick for respecting the right distances and proportions of the figure is to draw all of the body's limbs in full, even those that you cannot see at all, as if the model is transparent. This way we can be sure that all the limbs will be proportioned and positioned at the correct height.

04: Using solid shapes – profile and back view

We can best observe whether the posture is correct from the side. As mentioned, when we start working on the profile of our model, we can see how much more evident and accentuated the S-shape of the spine is (fig.04a).

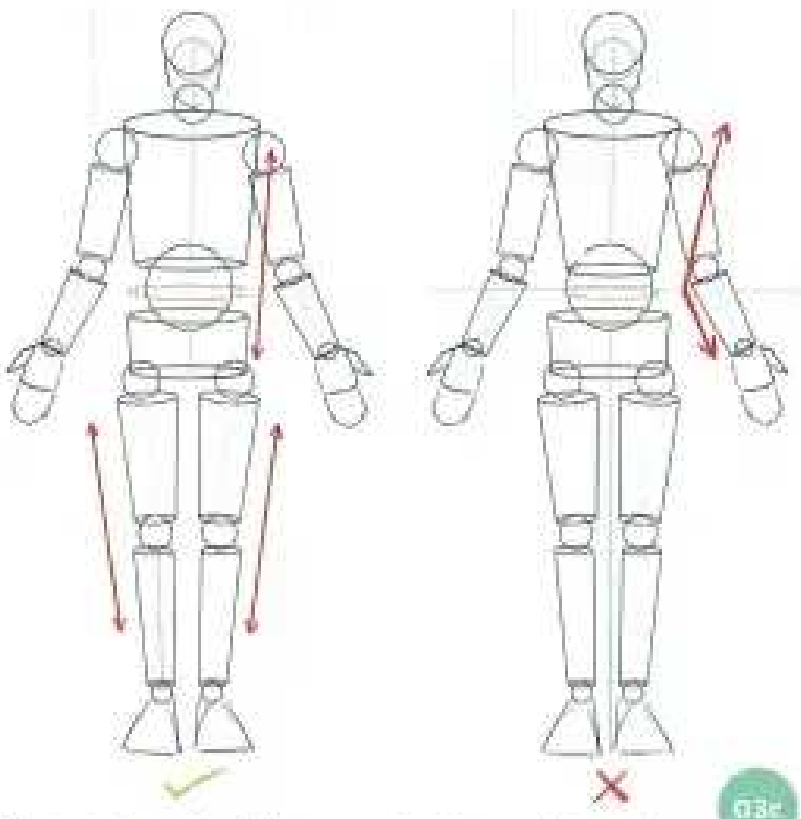
03a

▲ Front view with solid shapes



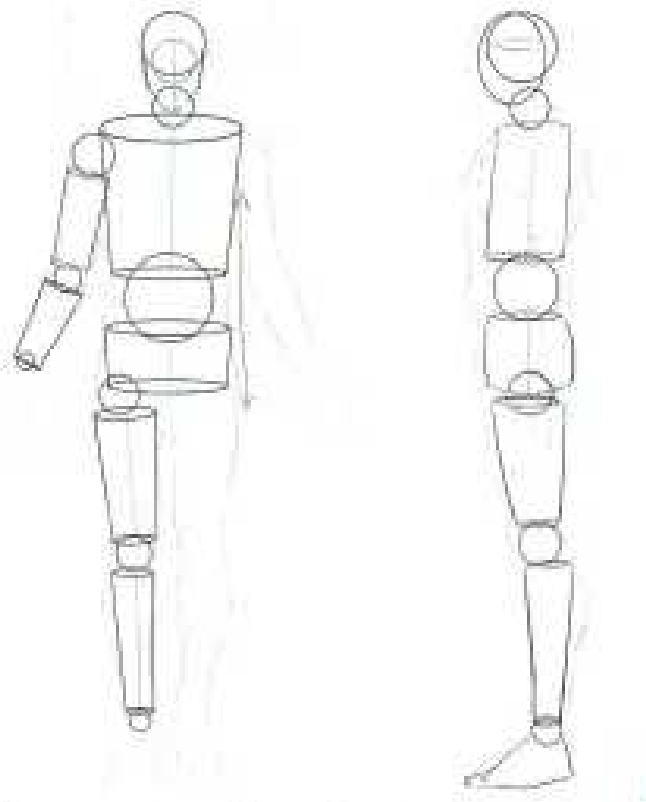
03b

▲ You can see more of the S-shape of the spine in a 3/4 view



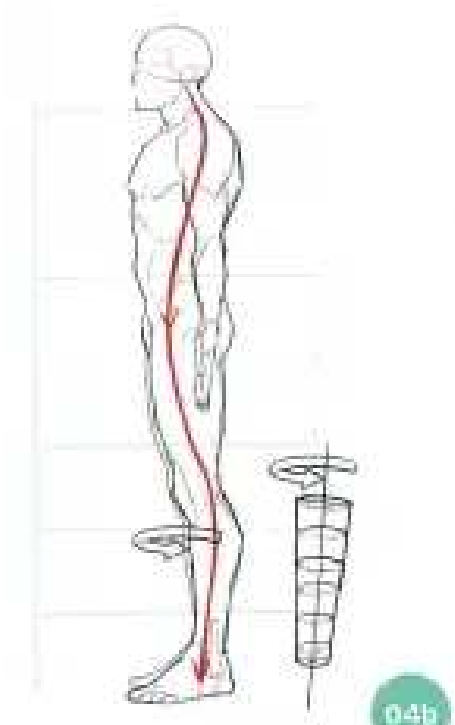
03c

▲ The male torso doesn't have an angle change at the waist



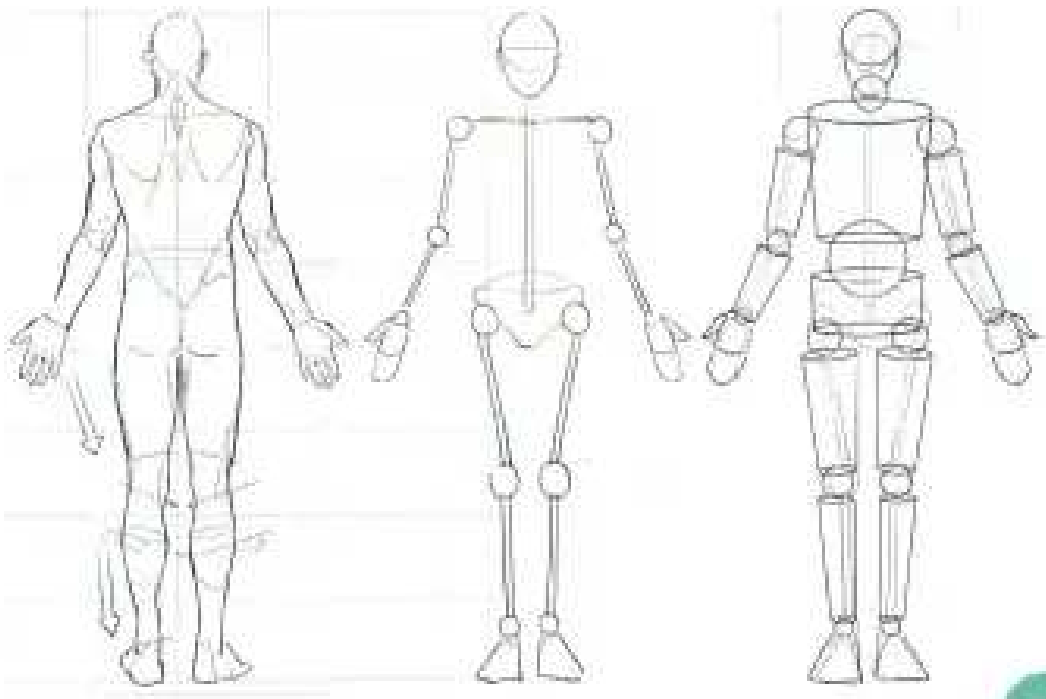
04a

▲ Note the S-curve of the spine from the profile view



04b

▲ The legs have a slight tilt



04c

▲ Back view with solid shapes

Special attention should also be paid to the area of the basin that protrudes slightly forward and then goes back near the pubic area. We have to place a sphere for the articulation of the pelvis and legs, and also include the buttock area. The legs, as well as the spine, will not be built on a perfect vertical axis but will instead be slightly tilted (fig.04b).

When we work on the figure seen from behind, it will be helpful to refer to the first studies we did to build the front view of the figure (fig.04c).

05: Using solid shapes – head proportions

Finally, we can also build and understand the correct proportions of the face using geometric shapes as demonstrated in fig.05.

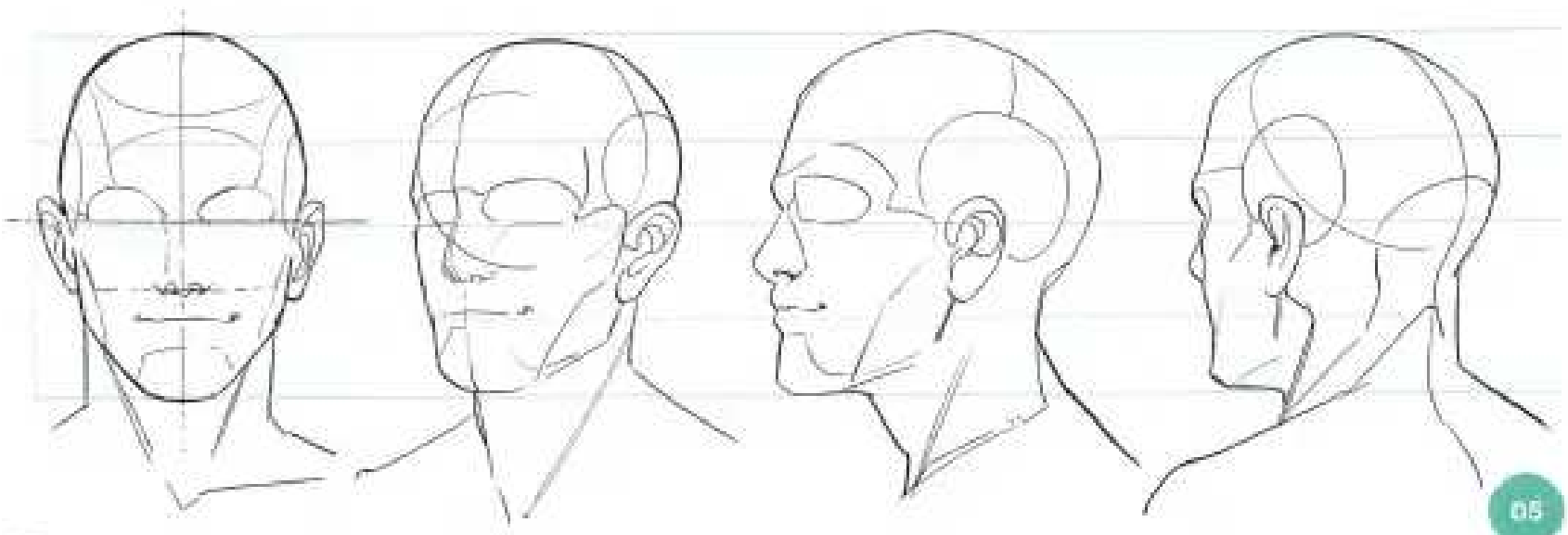
Start by drawing a straight line vertically down the center of the page, and then a horizontal line that intersects the first one. These two lines will be the center of our face as seen from the front. Place the eyes along the horizontal line and the nose and mouth along the vertical line.

The human face can be divided vertically into four equal parts from the top of head to the chin (in aesthetics this form corresponds to the height of the ear), and another four equal parts horizontally, from the root of the ears.

The eyes are positioned at the center of this imaginary grid and, as a rule, the distance between one eye and the other is that of another eye. The inner corners of the eye must match the width of the nostrils. We get the width of the mouth by drawing two vertical lines from the pupils. Obviously this construction of the face is an approximation akin to a classic model. Actually every face is different and has different proportions. We'll get a completely different appearance just by moving the eyes out a bit, lengthening the nose, and widening the mouth.

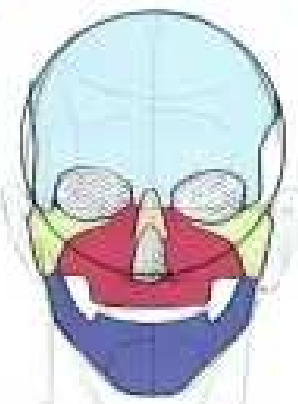
What I advise, and what I personally find to be very useful as well as fun, is to start from the classic grid and then change the size of the internal modules in order to create different appearances depending on the character that you are trying to create.

It will be fun and interesting to see how the face can change by even slightly changing the size of the modules that you have previously built.



05

▲ The proportional head



Drawing an archetypal figure

2D male

Part 02 | The skeleton

By Laura Braga

Comic artist and illustrator

The skeleton is crucial in the construction of the human figure. It is a structure within the body that is formed from a set of bones and cartilage tissue. From the skeleton the body derives its support and shape. It protects the internal organs (in particular the rib cage, skull, and pelvis) and serves to aid balance and movement because it is connected to the muscles.

"The skeleton will determine the physical features and moods depicted by the positioning of the body and by the gestures"

It is essential to understand the forms and proportions of the skeleton as this will help you to correctly represent a human figure. In this part we will study the bones of the skeleton, not from a medical point of view with the detailed characteristics of every bone and cartilage, but as a whole, as the carrier structure of the body. Only with an understanding of this important support structure can we draw a credible and realistic figure.

Drawing the skeleton will give solidity and added three-dimensionality to your drawing. Moreover, the skeleton will determine the physical features and moods depicted by the positioning of the body and by the gestures – the so-called "body language".

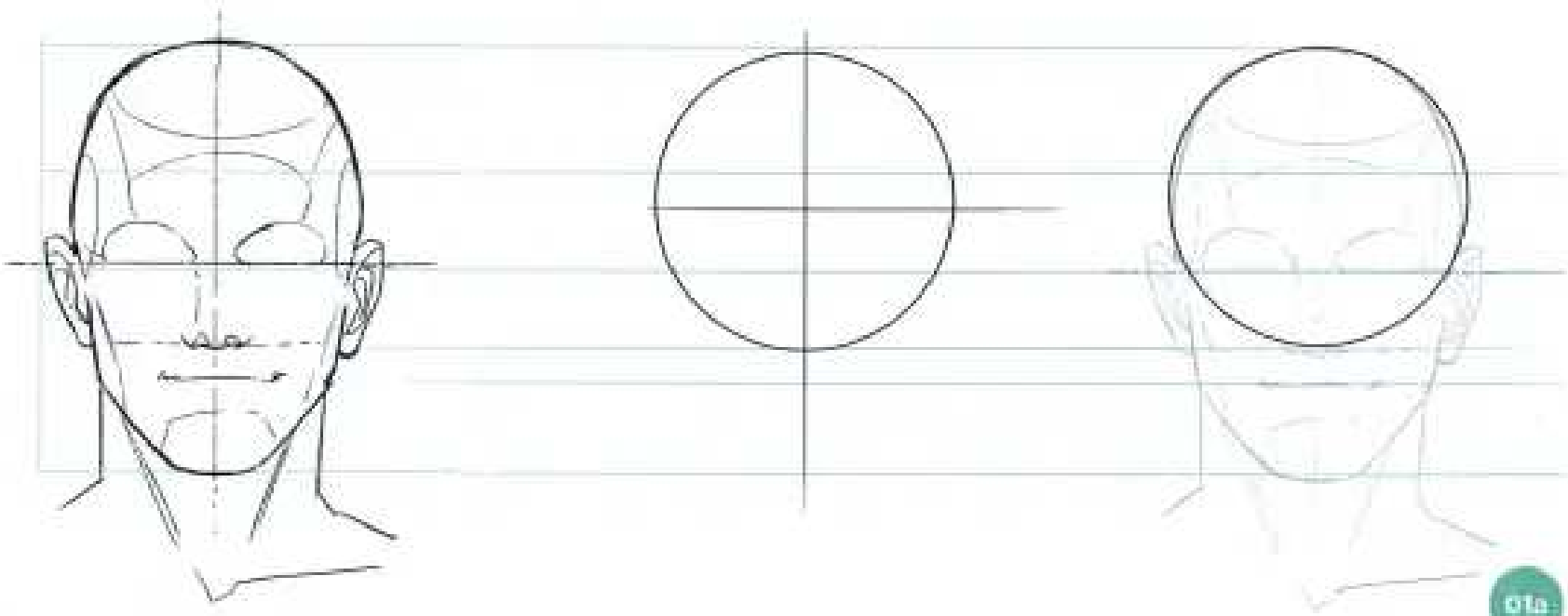
In our drawing, it's important to consider the proportions and shapes of the bones of the head, trunk, and chest, and of the bones of the limbs, shoulder, girdle, and pelvic girdle.

In addition to the bones, it is important to take into account the most important areas of cartilage, such as the ear and nose. Cartilage tissues are solid but very flexible.

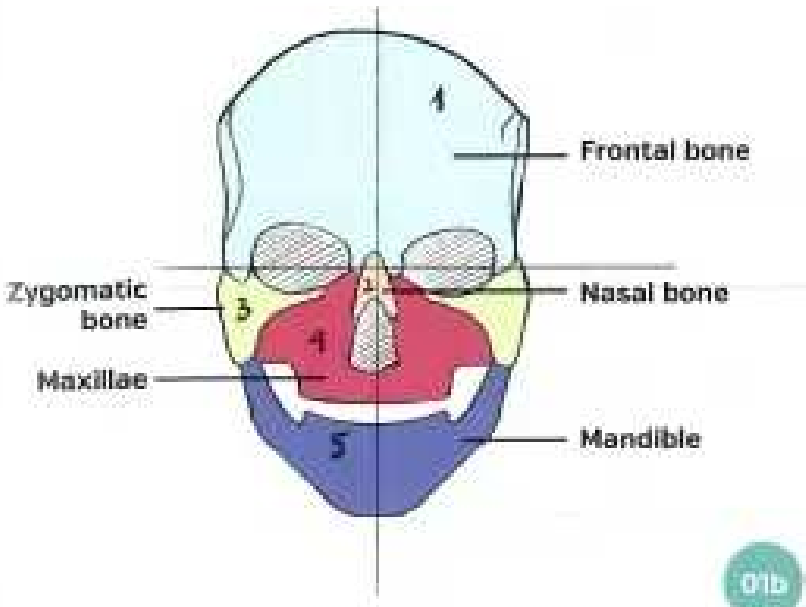
As mentioned, the human skeleton is the supporting structure of the human body and is formed by a set of bones, joined together by joints. The skeleton of an adult consists of 206 bones. We actually have more bones when we are newborns, roughly 270, but these fuse together during the periods of growth and the number reduces to 206. The size of bones also begins to decrease after the age of 45 years due to daily wear and tear.

The human skeleton is formed by two segments: the axial skeleton (head, spine, rib cage) and appendicular skeleton (upper limbs, lower limbs, girdles).

The girdles are the connections between the appendicular and axial skeletons. The shoulder girdle is formed by the collarbone and shoulder blade, and the pelvic girdle is formed by the bone of the hip and the sacrum. Don't

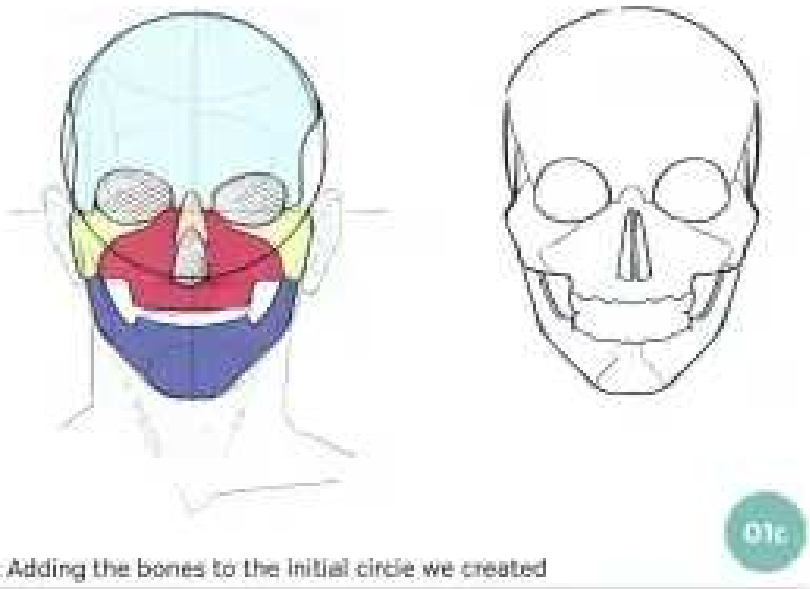


A The shape of the skull



01b

▲ Identifying the important bones in the face



01c

▲ Adding the bones to the initial circle we created

be **intimidated by these names and technical classifications. You'll see that correctly drawing a figure starting from the skeleton is easy if you are aware of some simple notions.**

01: Axial skeleton – skull

When looking at the axial skeleton, we will start from the head, always keeping in mind what we have learned in the previous part of this chapter about proportions. Looking at the head, we can distinguish the skull and the bones of the face. Depicting the skull is very simple – just draw a circle. From this circle we're going to build the face [fig.01a].

The bones of the face are very important to our illustration because, as their name implies, they are going to define the shape and overall look of the face. As shown in fig.01b, they include the:

1. Frontal bone (forehead)
2. Nasal bones (nose)
3. Zygomatic bones (cheekbones)
4. Maxillae (which form the upper jaw)
5. Mandible (mandibular bone or jaw bone).

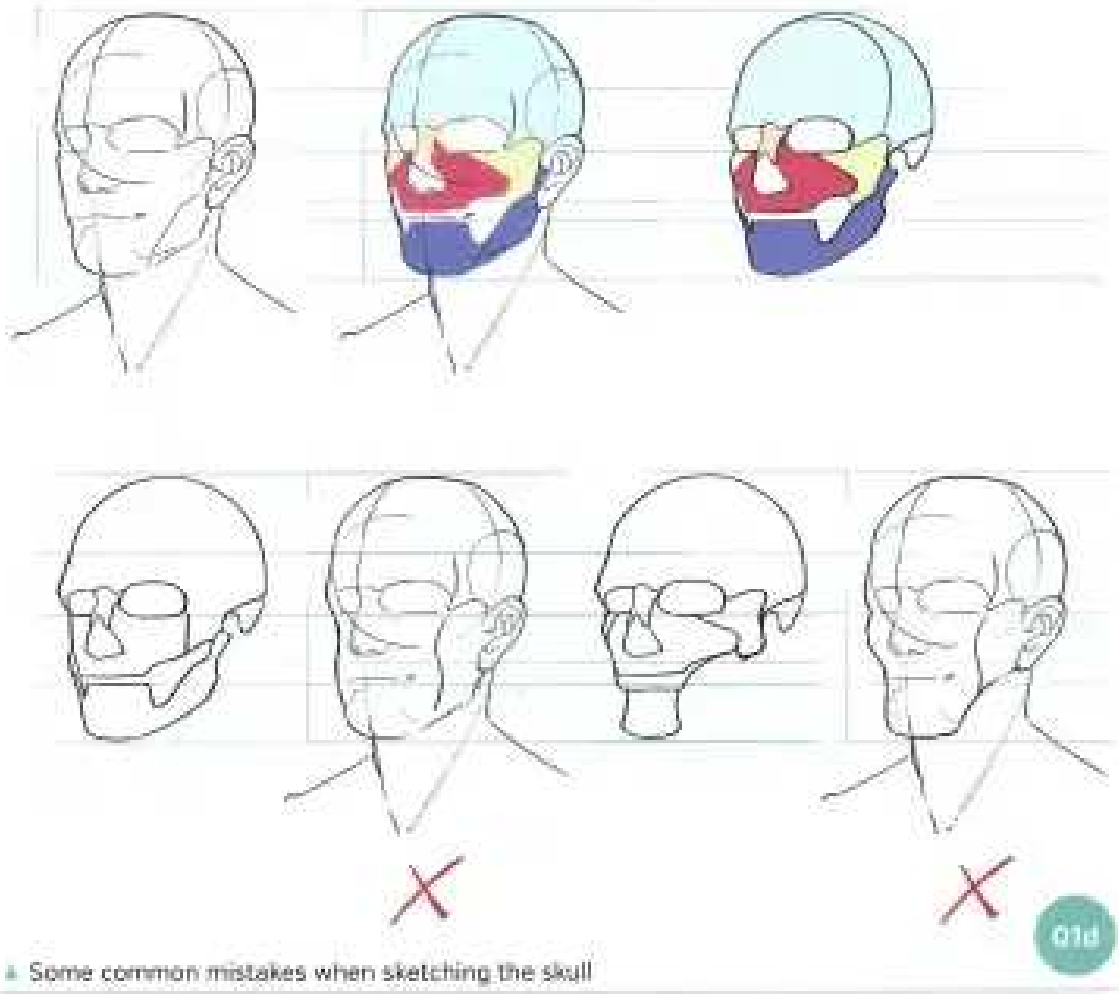
There are also other bones, around 22 in the face, but we will take care only of those that we need for our illustration.

Starting from the drawings from part 01, we'll be able to build the bones of the head. The frontal bone will be of particular importance for our illustration, and we will draw it on top of our circle [fig.01c]. It will delimit the entire area of the forehead, from the hairline to the eyebrows (brow ridges).

On the central vertical axis of the face, under the frontal bone, we find the nasal bone that will help us draw the right position of the nose. The orbital cavities are defined by the zygomatic bone and by the jaw bone. They will help us to define the area of the face between the frontal bone and the mouth. The cheekbone and the projection that this will create on the face is of particular importance as it will give personality and credibility to our character.

Finally, it will be important to study the jaw bone. By understanding its shape and structure we'll be able to correctly move and draw the mouth of our character.

Fig.01d shows some common mistakes when sketching the skull to help you better understand how important it is to know the shape of the bones and draw a face correctly.



01d

▲ Some common mistakes when sketching the skull

"The vertebral column consists of 33–34 vertebrae, which are short, irregular bones arranged in a series, one above the other, to form a long flexible rod that supports the body"

02: Axial skeleton – spine and rib cage

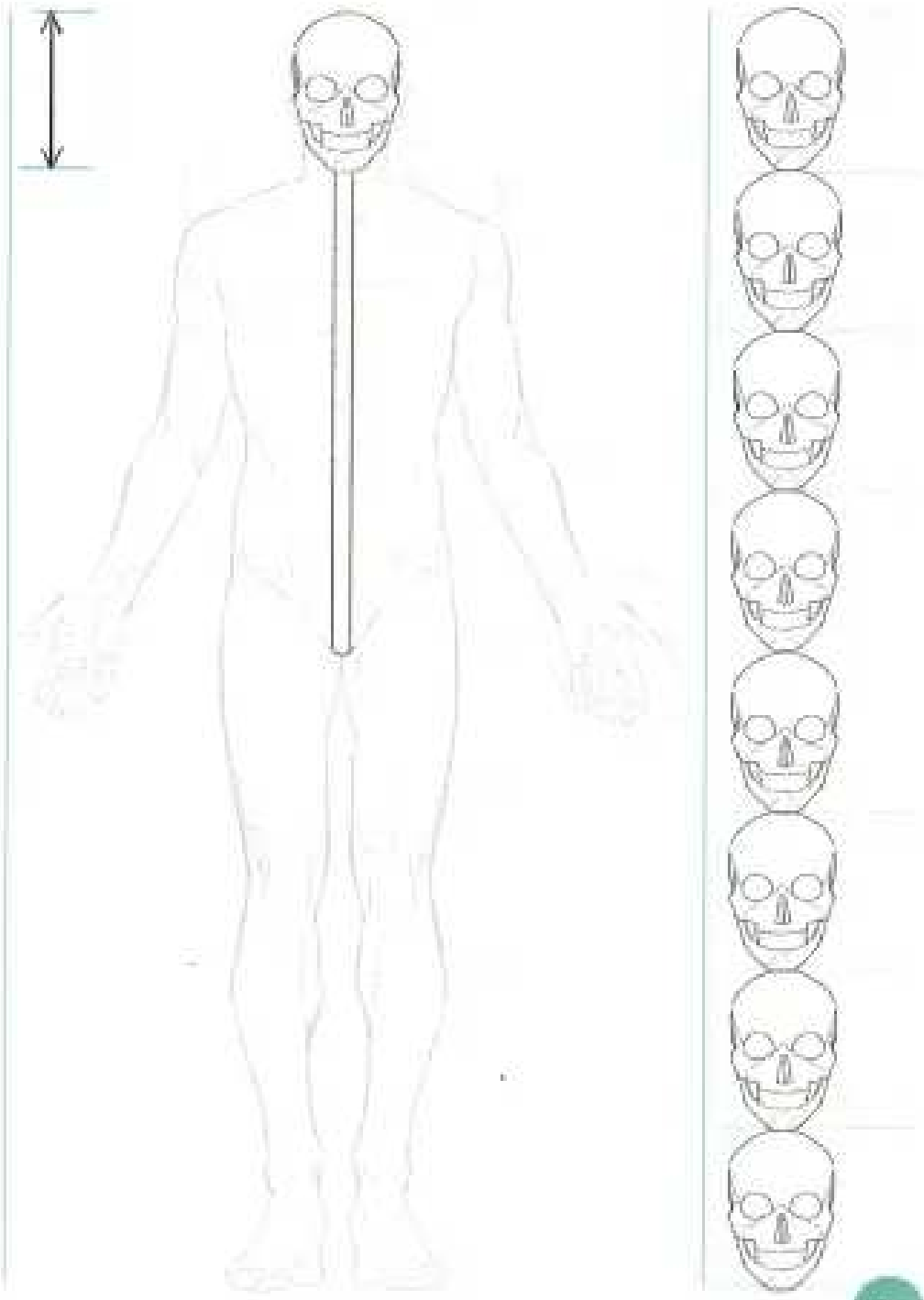
The spine, or vertebral column, is the axis and backbone of the body (fig.02a). For this reason it is hugely important to get it right: the whole human form is designed around this axis and therefore we need to design our figure around it as well.

The vertebral column consists of 33–34 vertebrae, which are short, irregular bones arranged in a series, one above the other, to form a long flexible rod that supports the body. For us, it will serve as a point of reference for understanding the behavior and position of our model.

We will draw the spine simply as a flexible solid form that starts from the skull and ends in the lumbar region, always taking into account the proportions studied in the previous part of this chapter. The vertebral column consists of several regions (fig.02b):

- the **cervical spine** is in the region of the neck. The vertebrae which are located in this region form the joint that connects the skull to the spine;
- the **thoracic spine** covers the region of the chest. The vertebrae in this region are articulated with the corresponding ribs forming the rib cage;
- the **lumbar spine** includes the vertebrae that form the support of the abdomen;
- the **sacral and coccygeal areas** are the last two regions, though we won't go into these much here as they are not visible in our drawing.

The rib cage is the container that protects the internal organs. When drawing our model, it is always good to remember its proportions and dimensions (fig.02c).



02a

▲ The spine is the body's central column

The rib cage is formed by 12 pairs of flat, thin and arched bones (the ribs) and a flat bone located in the central part of the chest (the sternum).

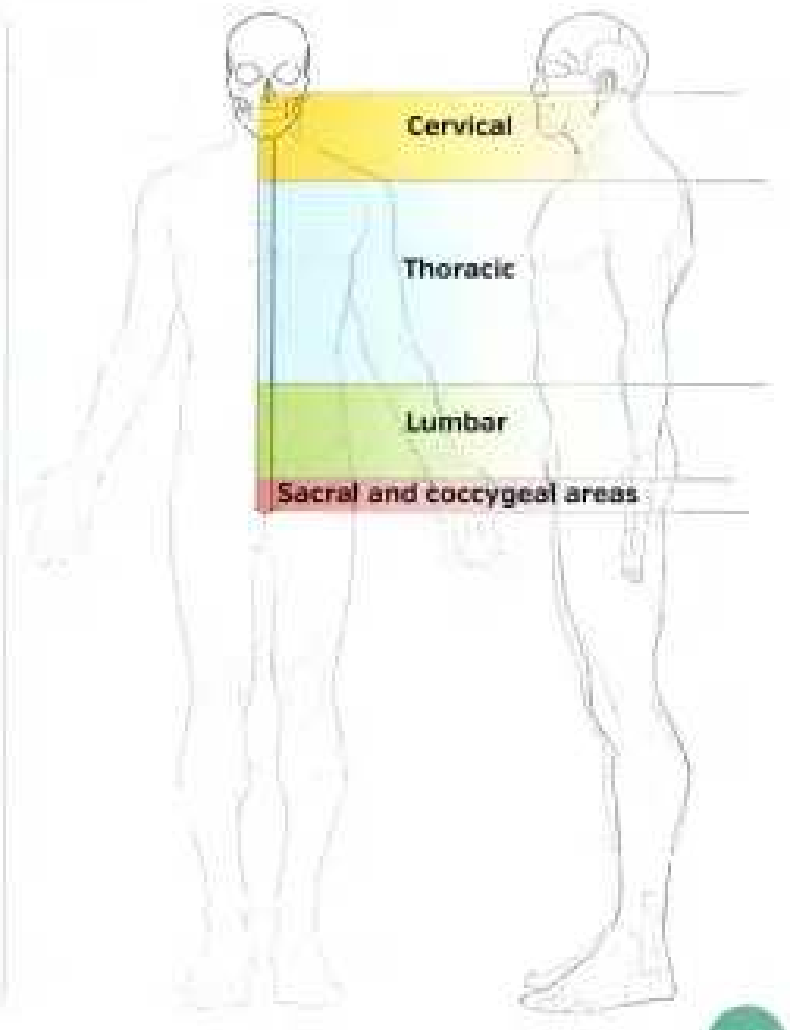
The ribs are attached posteriorly to the vertebrae and anteriorly to the sternum through the costal cartilage, which lengthens the ribs and also contributes to the elasticity of the rib cage. The last two pairs of ribs do not reach the sternum however, and so are called "floating ribs" (fig.02d).

03: Appendicular skeleton – upper limbs

The appendicular skeleton includes the upper limbs (arms) and lower limbs (legs) (fig.03a). The skeleton of the upper limbs includes: the upper arm bone (humerus), the bones of the forearm (ulna and radius), and the bones of the hand, formed by the carpal, metacarpal, and phalanges.

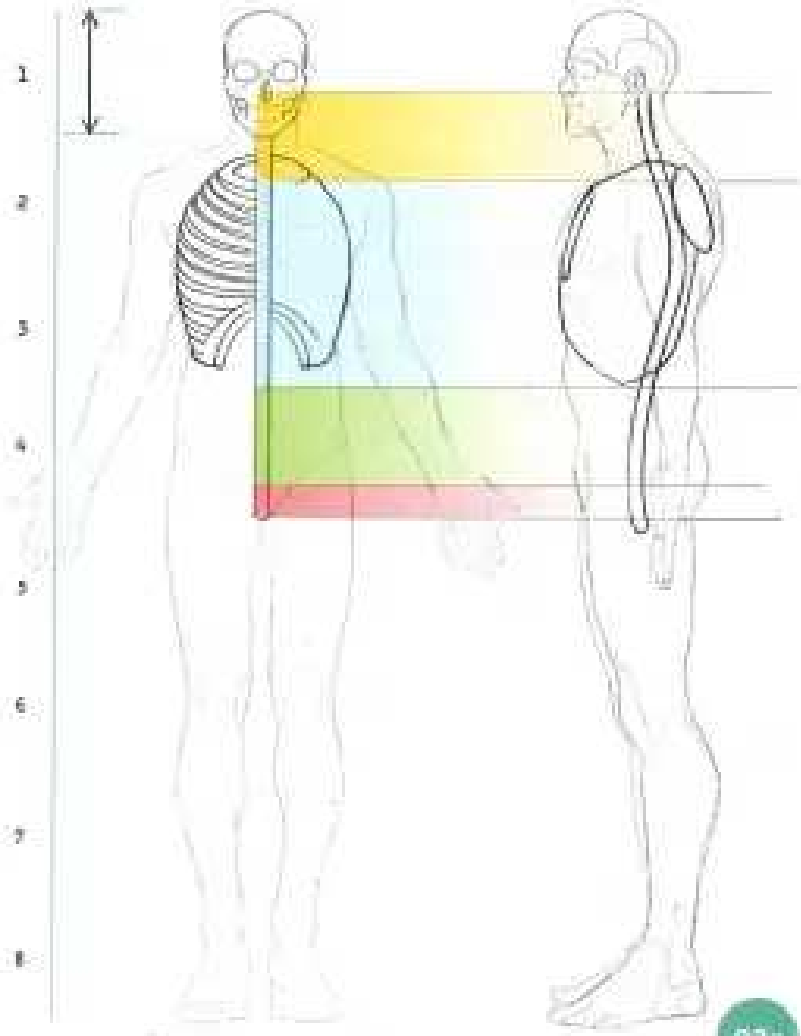
In our illustration we will therefore divide the upper limbs segment into two parts, which will include the upper arm and the forearm (fig.03b). We'll then add a small segment which will include the hand.

The humerus is a long bone that goes from the scepula (shoulder joint) to the radius and ulna (elbow joint). The radius and ulna are the bones of the forearm, which connect to the bones of the carpus (wrist). The bones of the carpus are connected to the



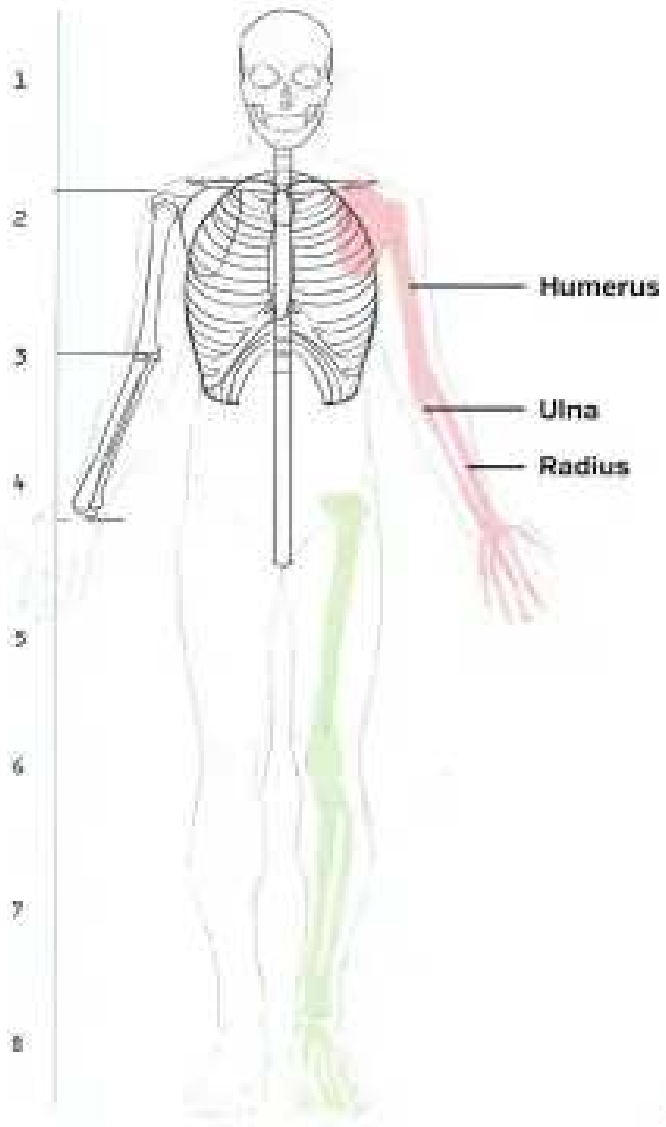
02b

▲ The various regions of the spine and their proportions



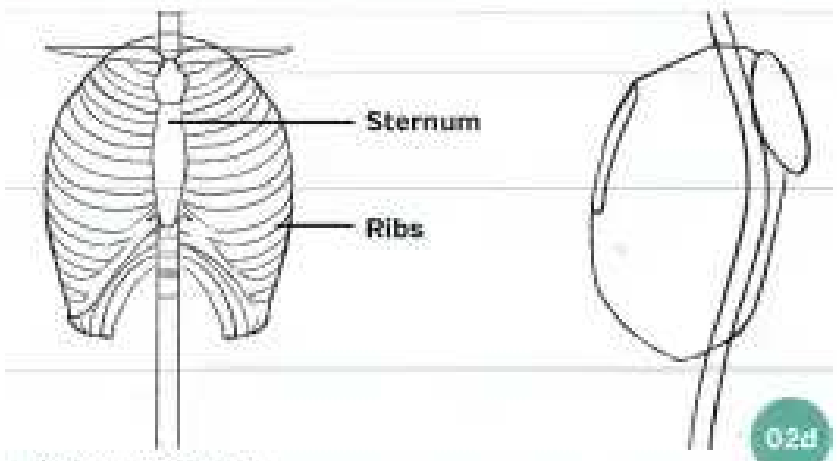
02c

▲ Placing the rib cage



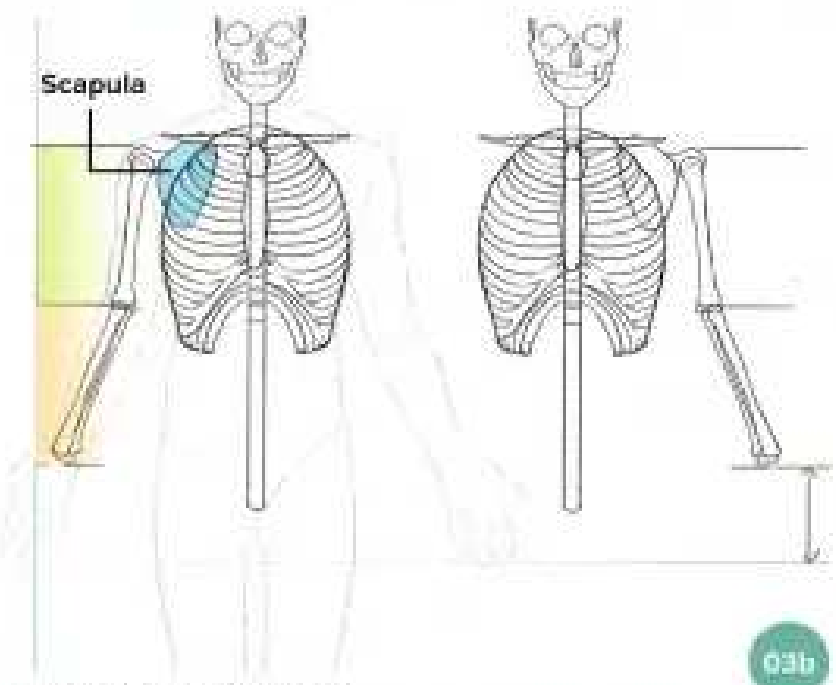
03a

▲ The appendicular skeleton includes the upper and lower limbs



02d

▲ Shaping the rib cage



03b

▲ Focusing on the upper limbs

metacarpal bones (palm), which are connected to the phalanges of the fingers. You can see the bones of the hand in more detail in step 06.

These notions are important because knowing what's really inside the volumes that we draw makes it easy to build the correct anatomy for our model.

"For a proper understanding of the anatomy and to draw it correctly, you should keep in mind how these bones are placed in our bodies, their size and volume, and most of all their function"

04: Appendicular skeleton – lower limbs

The bone structure of the lower limbs is similar to that of the upper limbs. The skeleton of the lower limbs includes: the thigh bone (femur – the longest bone in the body), the bones of the lower leg (tibia and fibula), and the bones of the foot (consisting of the calcaneus, tarsal, metatarsals, and phalanges).

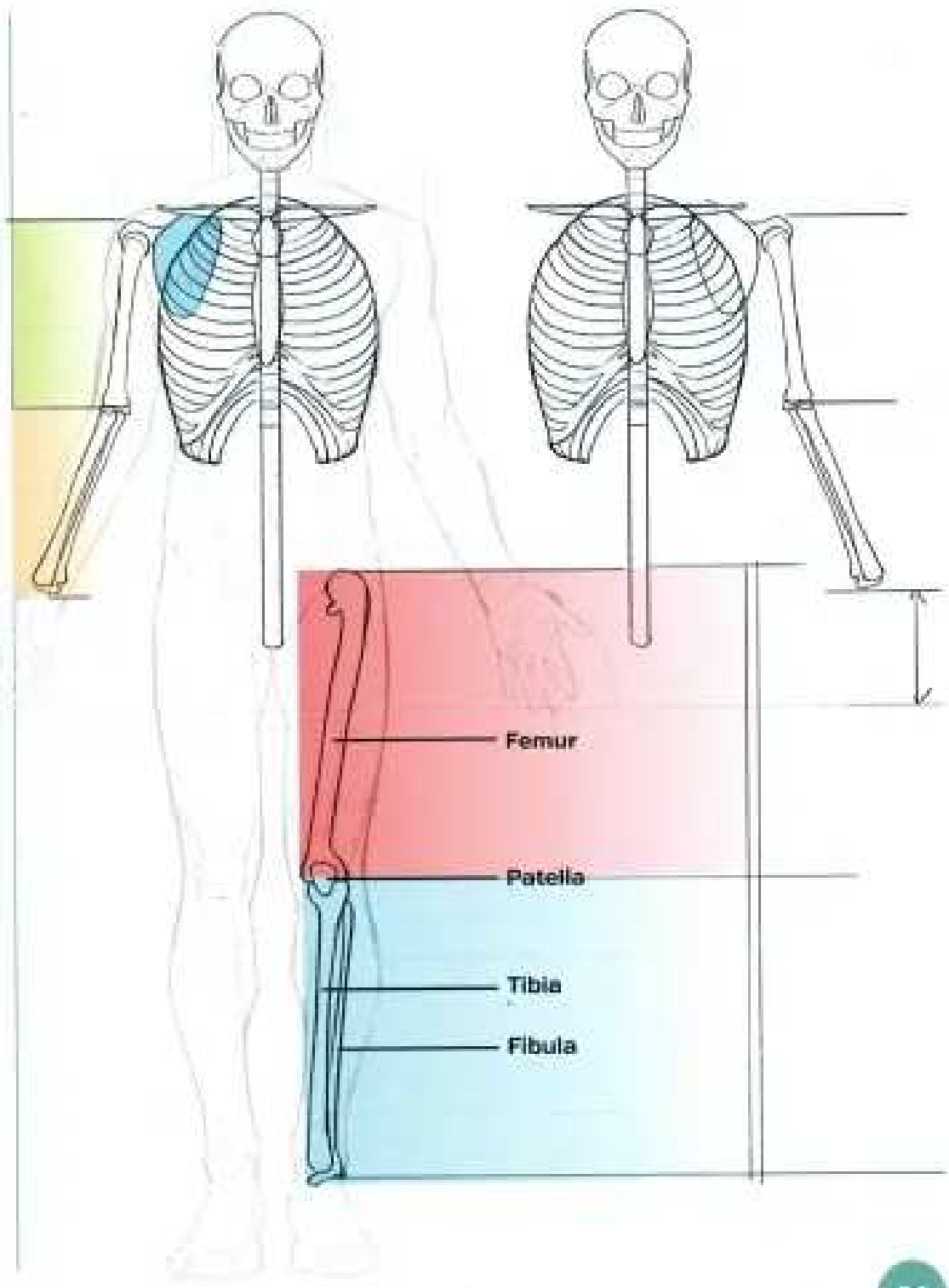
The femur supports the thigh; it is joined with the hip joint at the upper end and with the tibia and the knee joint at the lower end. The inner part of the knee also contains the patella bone that allows the movement of the leg.

The bones of the leg are the tibia and fibula, and both end forming the ankle joint. You can see the bones of the feet in more detail in step 06.

05: The shoulder and pelvic girdles (cartilages)

The bones that connect the appendicular skeleton to the axial skeleton are known as the girdles. The shoulder girdle includes the clavicle and the scapula, and the pelvic girdle includes the hip bones.

For a proper understanding of the anatomy and to draw it correctly, you should keep in mind how these bones are placed in our bodies, their size and volume, and most of all their function.



04

▲ Gauging the proportions of the bones in the lower limbs

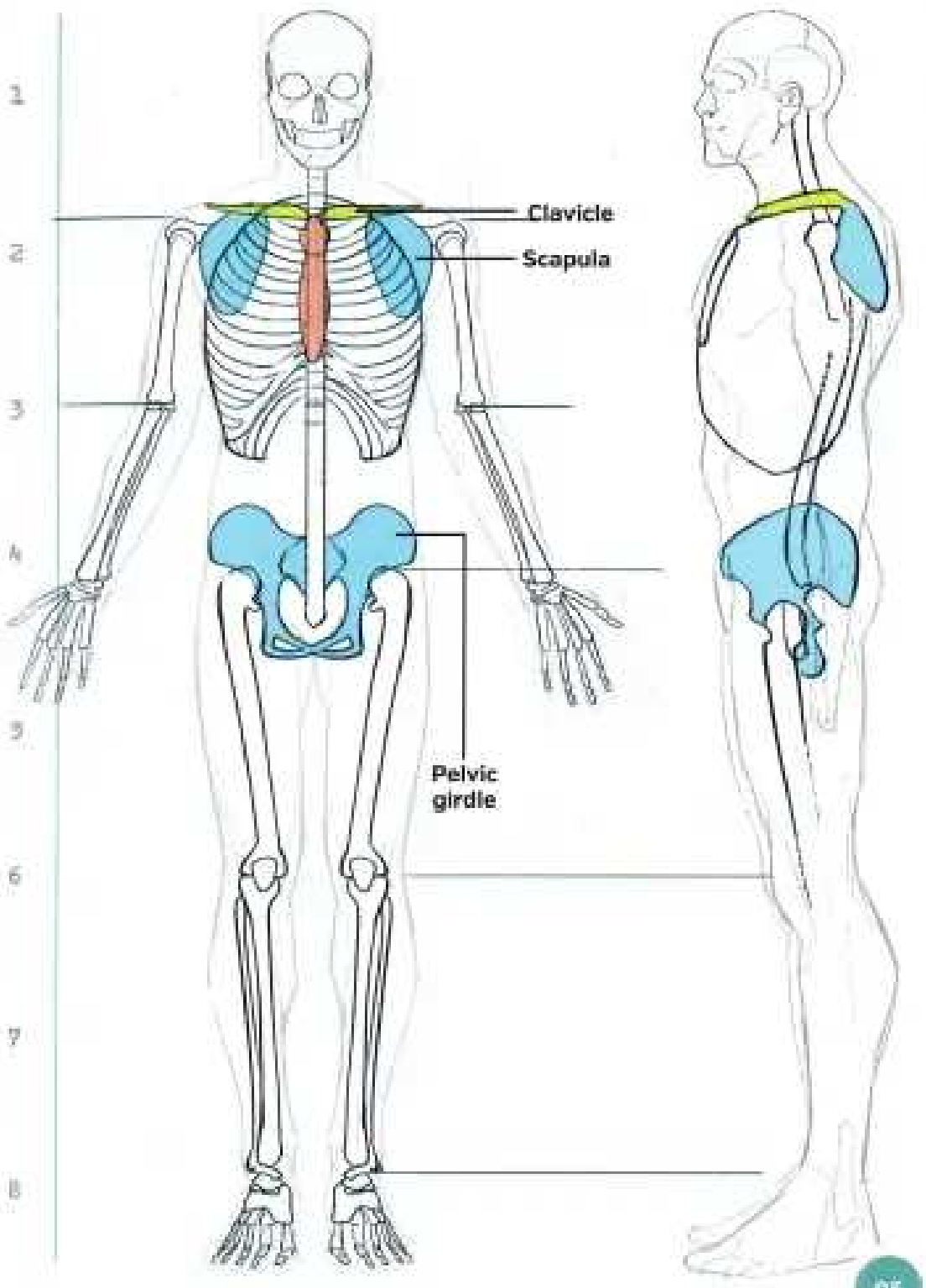
06: Bones of the hands and feet

The hand can be broken down into three sections, which you can observe in fig.06a: the carpals (wrist), the metacarpals (the palm), and the phalanges (fingers). There are nineteen bones in each hand and each finger has four bones: one metacarpal and three phalanges (proximal, middle, and distal), with the exception of the thumb which only has three – it lacks a middle phalanx (singular of phalanges).

The wrist is made up of eight individual bones, which collectively are known as carpal bones. The carpals join metacarpals to the radius and allow for the range of movement and rotation.

The metacarpals correspond with the region of the palm and is formed by five separate bones, each of which is associated with each finger. The phalanges of each digit extends from the end of the metacarpal.

The phalanx nearest the metacarpal is called the proximal phalanx. It is the longest of the three. Next is the middle phalanx (remember that the thumb lacks this one). Finally the finger tip is the distal phalanx. It is usual to name the fingers with the number linked



05

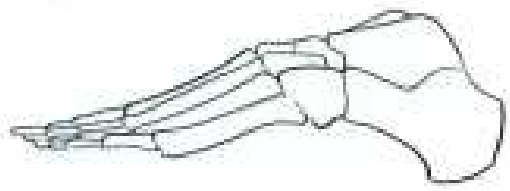
▲ Placing the girdles in the body with appropriate proportions

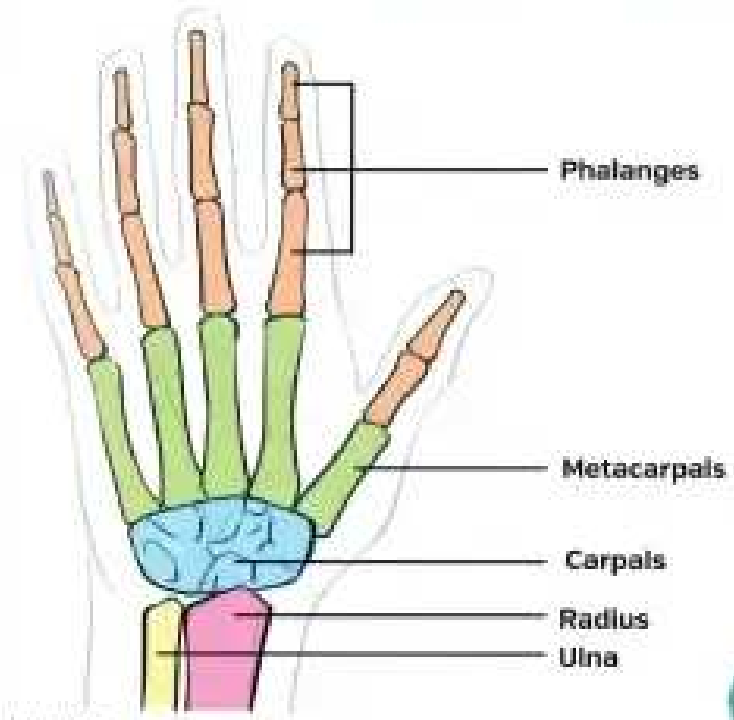
"The foot is similar in construction to the hand. There are also three sections: the tarsals (ankle), metatarsals (mid-foot), and the phalanges. As with the thumb the big toe only has two phalanges."

to their position; after the thumb, we have the second (index) finger, third (middle) finger, fourth (ring) finger, and fifth (little or pinky) finger.

The foot is formed of 26 bones, including the ankle, which mediates the continuity with the leg and the heel, which is the rear end of the foot (fig.06b).

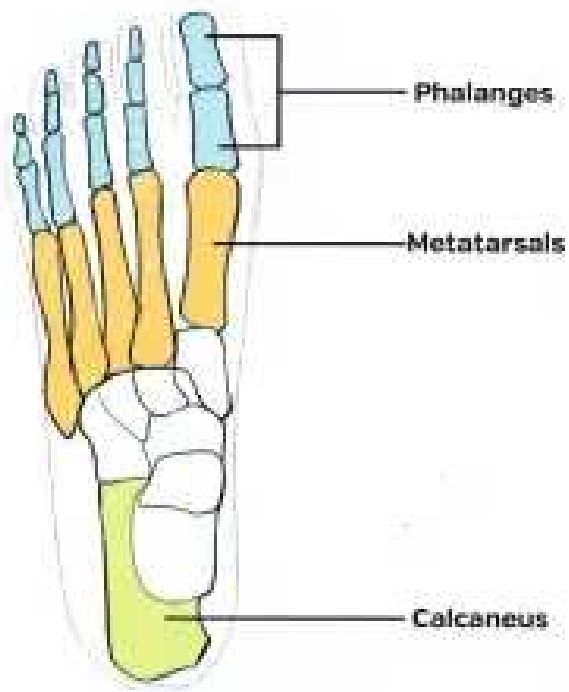
The foot is similar in construction to the hand. There are also three sections: the tarsals (ankle), metatarsals (mid-foot), and phalanges (toes). The big toe is the counterpart of the thumb and most voluminous of all the toes. As with the thumb, the big toe only has two phalanges. Looking at the design you will notice general similarities between the characteristics of the hand and foot.





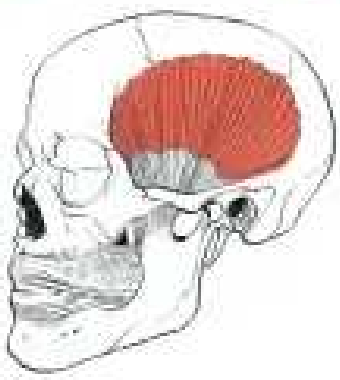
06a

▲ Identifying the bones of the hand



06b

▲ Identifying the bones of the foot



Drawing an archetypal figure

2D male

Part 03 | Muscles

By Laura Braga

Comic artist and illustrator

In this third part we will look at the muscles, which are vital for the proper construction of the human form. Understanding the form and function of muscles adds to our understanding of the dynamics of the body.

The muscular apparatus is especially important because it allows the movement of the various body parts, and also governs the numerous vital functions such as breathing, blood circulation, and digestion. We will look at the muscles of the major body parts and how they interact with each other to perform the range of human movement.

01: Muscle types

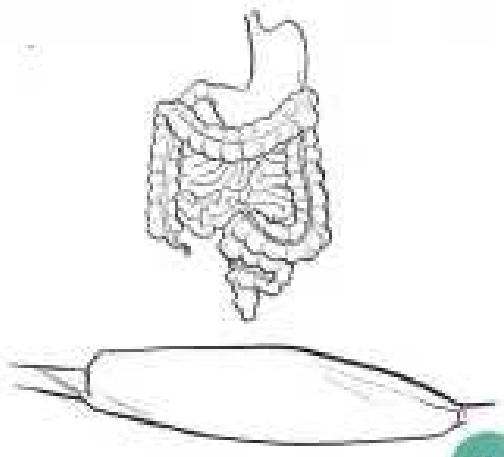
There are three different types of muscle: smooth, cardiac, and striated. The smooth [fig.01a] and cardiac [fig.01b] are both involuntary muscles, which as the name implies we have no control over. They make up the internal organs and heart. We are more concerned with the striated, voluntary muscles [fig.01c]. These are the ones we can consciously control and they enable us to move about. They attach to the skeleton via tendons.

02: Skeletal muscles

When creating a drawing or model of the human form, it is important to understand not only the shape of muscles but also their correct placement, because this determines the curves and silhouette of our model.

It will therefore be important to properly represent the fleshy part of the muscles and their origin and insertion points. In this part we will study only the muscles that will serve our design; there is no need for us to learn about all of the muscles present in the human body.

Many of the muscles in our bodies work in pairs: one allows a movement in one direction (agonist) and the other allows the opposite movement (antagonist). For example the biceps allow for the flexion of the forearm by contracting and the triceps allow the extension of the forearm. Therefore nearly all movement is the result of agonist contraction and antagonist relaxation, and vice versa. It is a good idea to keep this in mind.



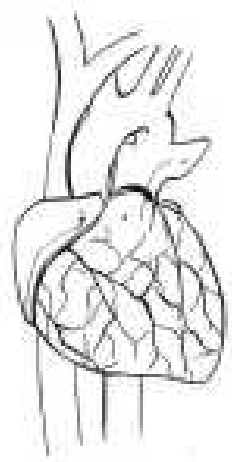
01a

▲ Examples of smooth involuntary muscles

03: Head muscles

The muscles of the head include mimic muscles or furriers (which are the muscles that allow changes in facial expression) and the jaw muscles (which allow movements of the jaw and chewing).

The furrier muscles include many bundles grouped around the eye sockets (orbicular muscles of the eyes), around the mouth (to move the cheeks and lips), and around the nose and the ear and forehead (to move the scalp). They are also called mimic muscles because they serve to express emotion through

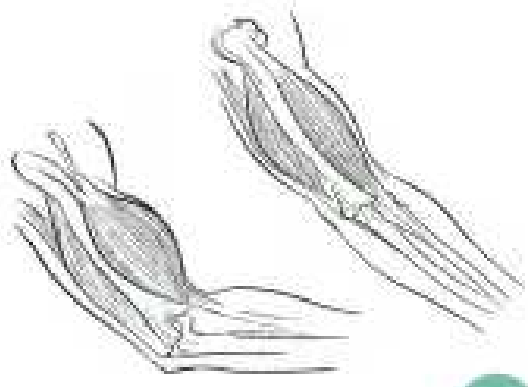


01b

▲ The heart is made from involuntary cardiac muscle

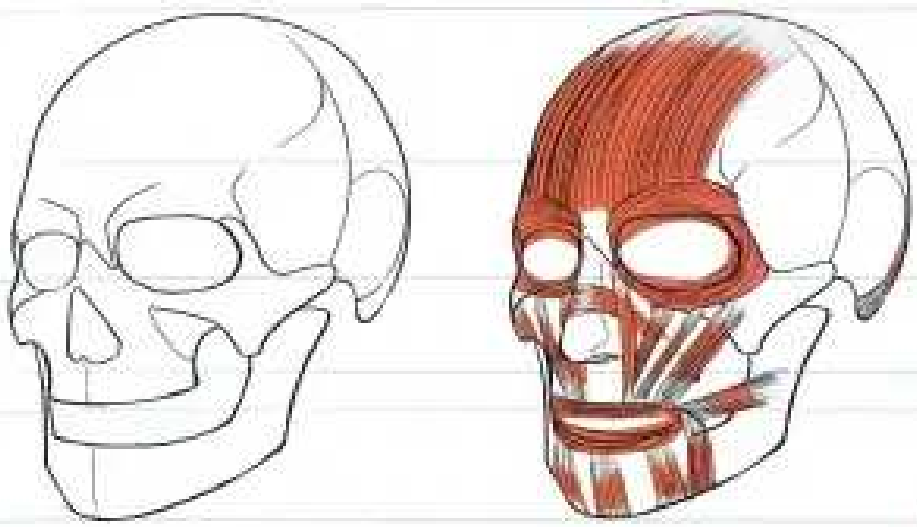
01c

▲ The voluntary striated muscles



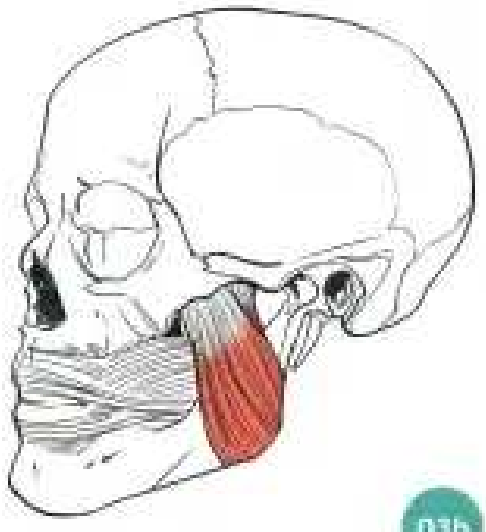
02

▲ An example of muscle pairs working together to bend the arm at the elbow



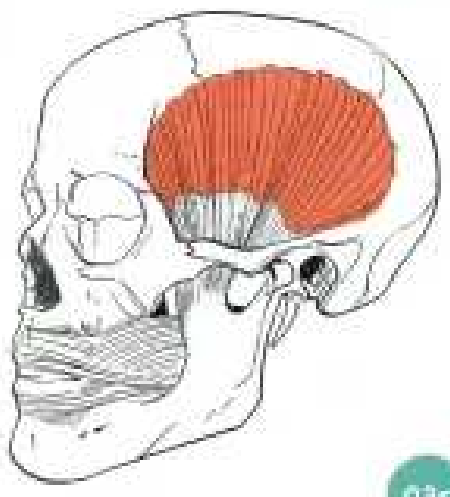
03a

▲ Some of the muscles of the face that are responsible for creating expressions



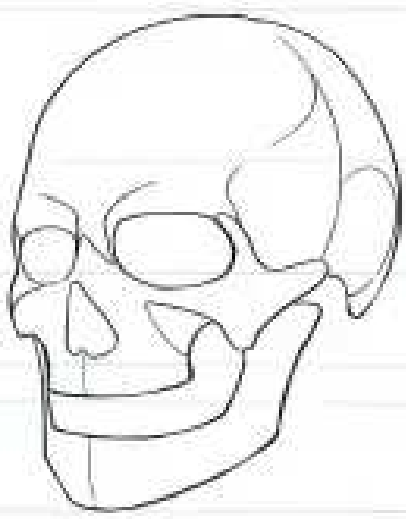
03b

▲ The powerful masseter muscle is more prominent in males



03c

▲ The temporalis attaches the jaw to the skull



03d

▲ The zygomaticus pulls on the lips when smiling

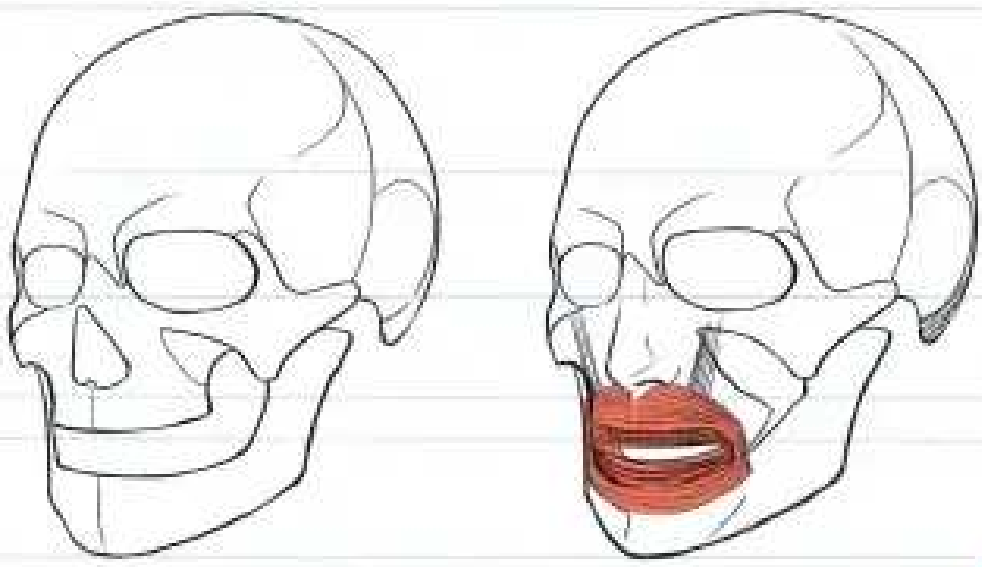
facial expressions. It is important to get the placement and volume of these muscles correct in order to give a model a realistic expression (fig.03a).

The masseter is a very powerful chewing muscle responsible for the movement of the jaw. It is often more defined and prominent in males than females, and connects the jaw bone to the skull (fig.03b).

The temporal muscle (temporalis) is not usually visible, but you can feel it contracting if you clench and unclench your teeth. It is a triangular muscle that starts from the lower temporal line and connects with a strong tendon to the jaw and passes through the gap of the zygomatic process (or arch) (fig.03c).

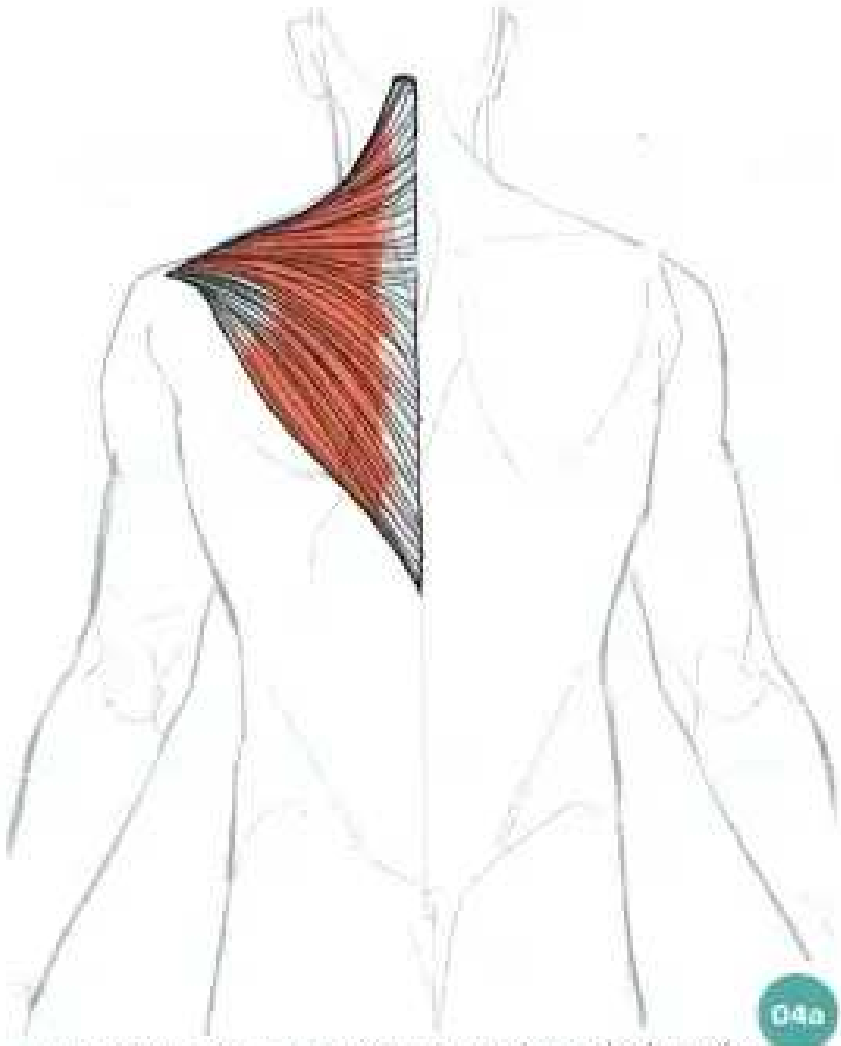
The zygomaticus major is a cylindrical-shaped muscle that starts at the lateral side of zygomatic bone and moves diagonally down towards the midline (middle of the body) to attach itself at the corner of the lip. With its activation, the corners of the lips are raised and move backwards to the cheeks (fig.03d).

The orbicularis oris muscle is an extended elliptical muscle that circularly covers the whole area around the lips to the lower edge of the nostrils. It is a single ring that regulates the opening of the contracting labial muscles (fig.03e).



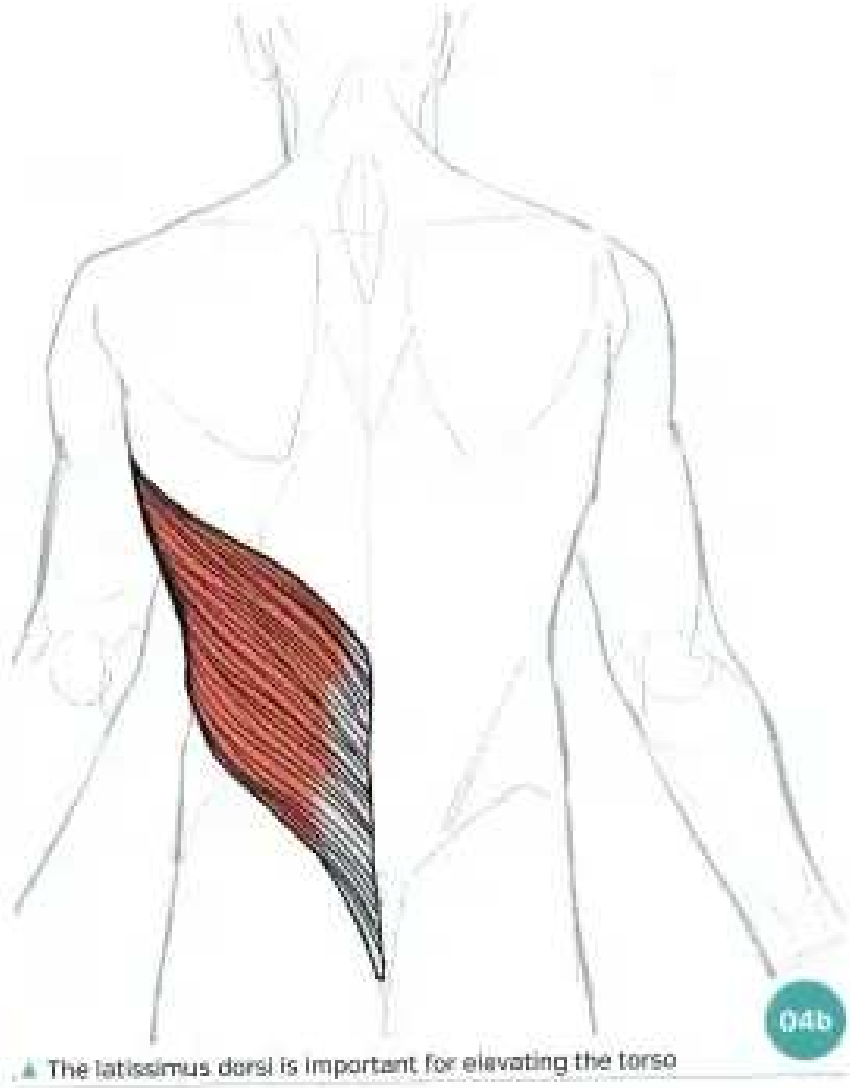
03e

▲ The orbicularis oris is another important muscle responsible for moving the mouth



04a

▲ The trapezius are the most prominent of the upper back muscles



04b

▲ The latissimus dorsi is important for elevating the torso

04: Torso muscles

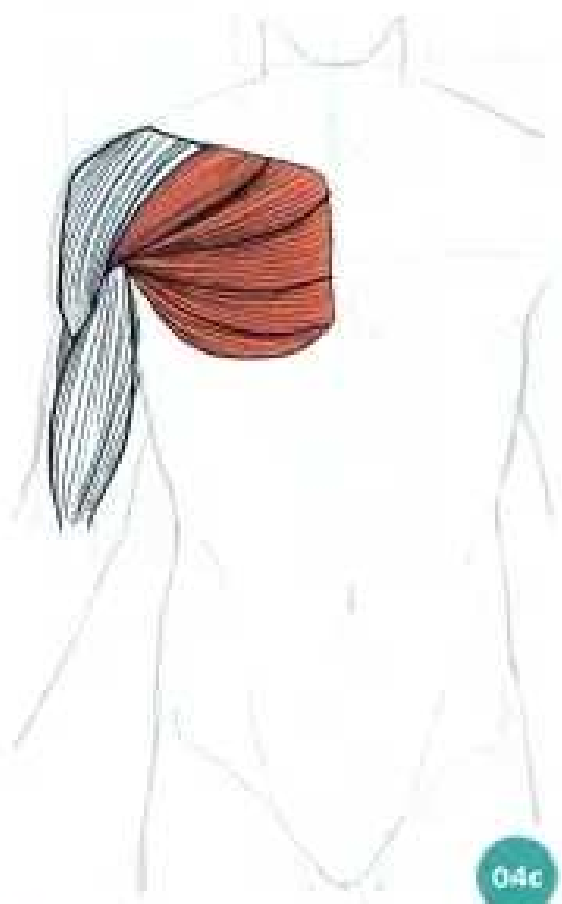
The muscles of the back are classified as muscles of the surface layer, of the middle layer, and of the deep layer. In the surface layer are the trapezius muscles, so called because of their shape. They are located in the neck and upper back, and assist in moving the shoulder and upper arm. As it raises, the arm moves back and rotates the head to the opposite side (fig.04a).

The triangular latissimus dorsi muscle is one of the larger muscles in our body. It covers the lower part of the back and the lateral part of the thorax. It makes the arm move backward and rotate inward and, with the arms still, elevates the torso (for instance when climbing) and the ribs (when breathing) (fig.04b).

The most important muscles for our design are the pectoralis major and the pectoralis minor, which sit on the front of the body. They attach on to the arm and determine, with contraction, our approach to the trunk (fig.04c).

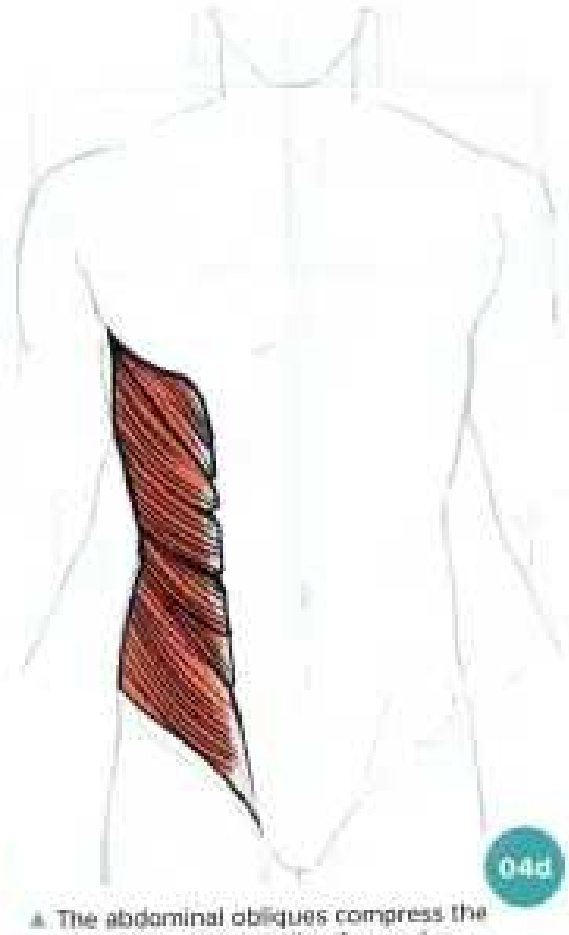
The chest cavity is separated from the abdominal cavity by the diaphragm.

The abdominal wall is composed of a series of muscles arranged in layers. For our purposes, we are interested in the abdominal obliques which interlock with the lateral edges of the latissimus dorsi (fig.04d). The rectus abdominis muscles (also known as the "abs") are stretched between the sternum and the pubis. They are muscles with a peculiar turtle-like shape, separated in the middle by the linea alba, a vertical connective band. Their contraction makes the



04c

▲ The pectoral muscles are more defined on the male form



04d

▲ The abdominal obliques compress the abdomen when bending forward

rib cage approach the pubis, causing the flexion of the spine. The external oblique muscle and the internal oblique muscle compress the abdomen and determine the body bending forward.

"The longest muscle group of the arm is the biceps. The biceps' origin is in the scapula of the shoulder and it reaches all the way down to the elbow; it acts both on the upper arm and forearm"

05: Arm muscles

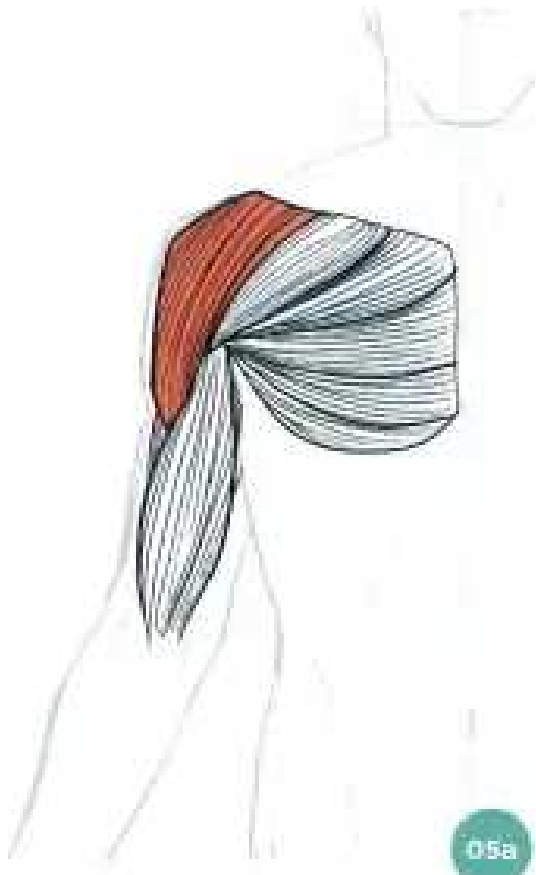
The arm muscles can be divided into shoulder, arm, forearm, and hand muscles. In human anatomy, the term "arm" refers to the portion of the upper limb between the shoulder joints and the corresponding elbow. The arm muscles have the functions of abduction (moving away), adduction (moving back), flexion (bending), and extension (elongating) of the limb. The bones of the forearm are composed of the ulna and radius, two bones that extend for the entire forearm to connect to the hand through the wrist joint.

The arm is attached to the chest by the pectoralis major and latissimus dorsi. The pectoralis major is classified as either flexor or extender. In fact, the muscle flexes the extended arm and extends the flexed one!

The shoulder muscles are the deltoids, which cover the lateral side of the shoulder joint. The deltoid has a triangular shape, with the base facing upwards and the apex (insertion) at the bottom. Its function is to raise the entire arm (fig.05a).

The longest muscle group of the arm is the biceps. The biceps' origin is in the scapula of the shoulder and it reaches all the way down to the elbow; it acts both on the upper arm and forearm (fig.05b). The brachioradialis (see next page), which is flat and elongated, lies behind the biceps. Its function is to flex the forearm.

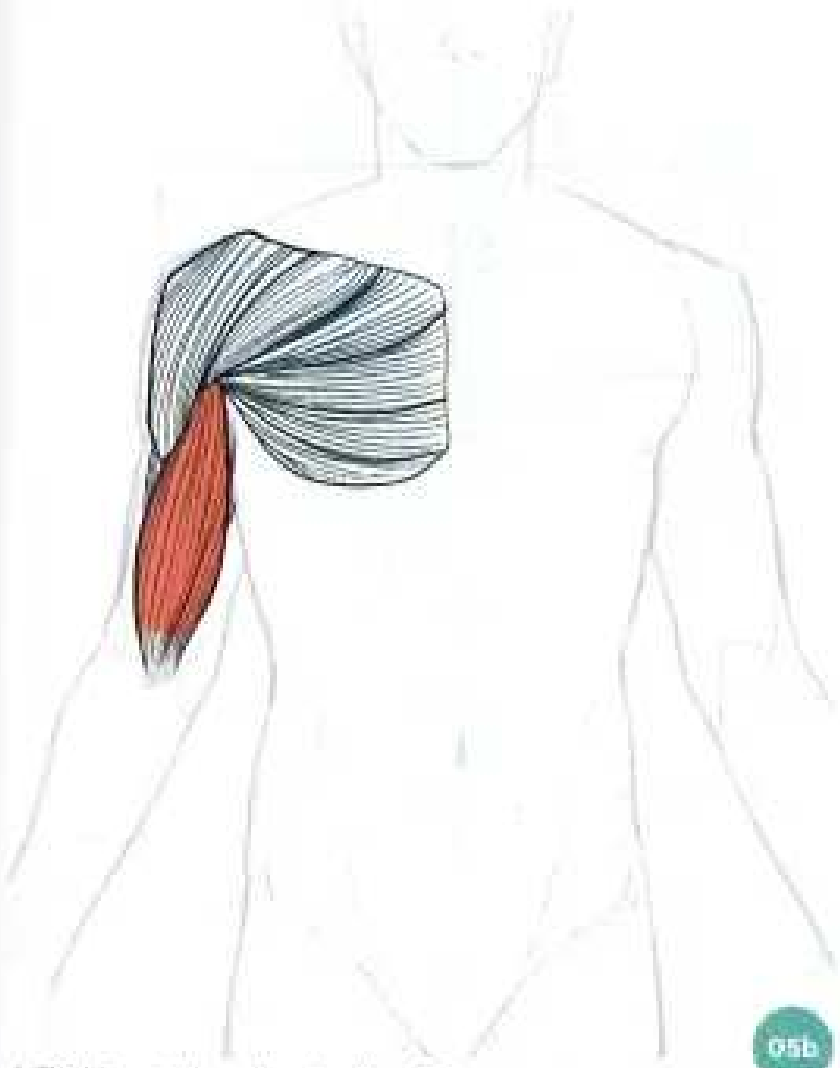
As mentioned in step 02, the biceps are one of a pair. Its opposite muscle is the triceps. The triceps are the main muscle group of the rear portion of the arm, acting as the extender of the elbow and also helping to adduct the arm (fig.05c).



05a

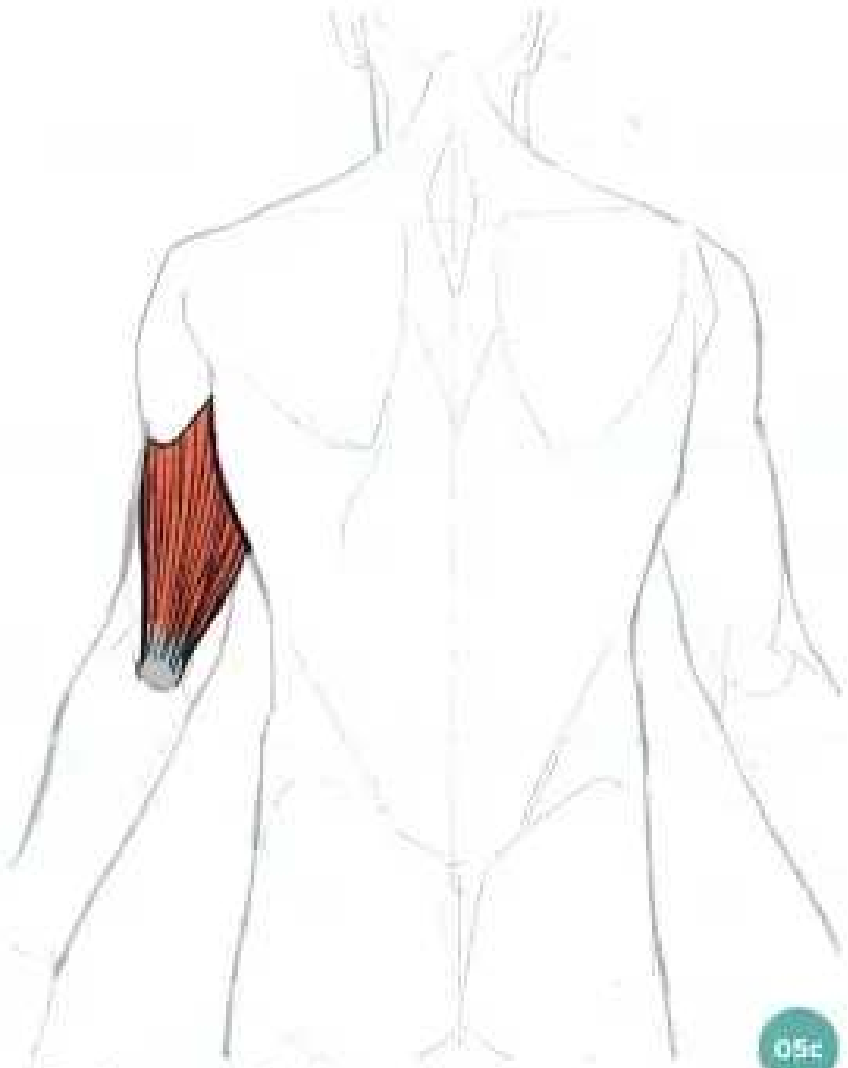
▲ The powerful deltoids are responsible for lifting the arm

For our purposes we only need to look at two of the forearm muscles, because they give shape and volume to the arm. They are the flexor carpi radialis, which is visible on the underside of the arm, allowing flexion of the hand



05b

▲ The biceps bulge when the elbow flexes



05c

▲ The triceps extend the elbow

and the inward rotation of the forearm (fig.05d), and the brachioradialis, an elongated muscle which allows the flexing of the forearm (fig.05e).

Finally we come to the hand. Looking at the drawings made in part 02, we can see the whole of the carpal and metacarpal with five joints that allow movement of the fingers. Hand muscles are located in the inner portion of the hand. Their function is to allow the movement of opening and closing the hand. You can see more on the muscles of the hands on pages 60–61.

"These muscles are fundamental to our drawing because they cover the whole front of the thigh and are responsible for moving the leg"

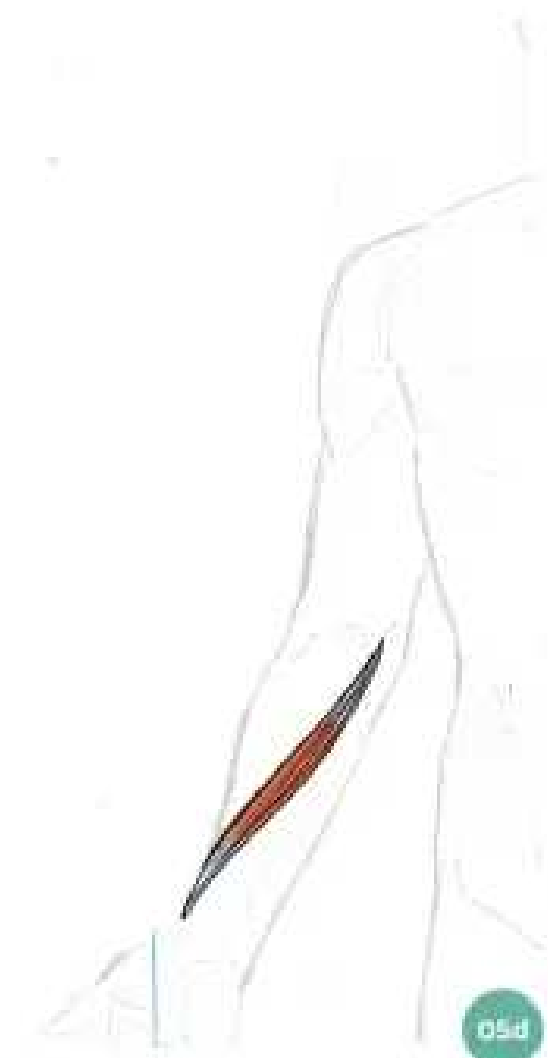
06: Leg muscles

The powerful thigh muscle group, the quadriceps femoris, is the largest of the anterior region of the thigh muscles and is made up of four pieces that are collected to a single tendon terminal. The quadriceps are the rectus femoris, vastus lateralis, vastus medial, and vastus intermedius (fig.06a). The vastus intermedius lies under the rectus femoris.

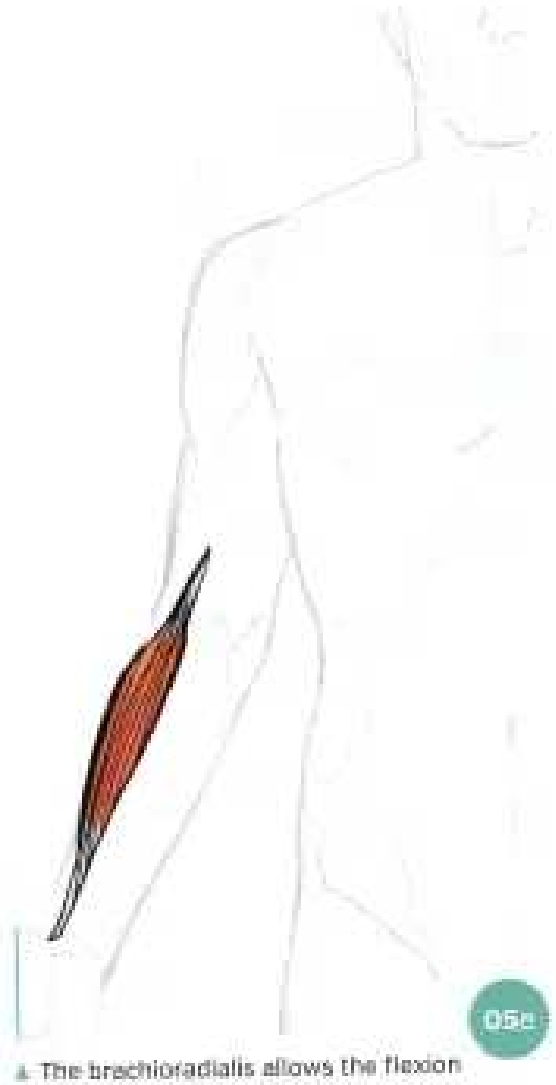
These muscles are fundamental to our drawing because they cover the whole front of the thigh and are responsible for moving the leg. When the knee is flexed, the contracting quadriceps stretch the leg; when the knee is extended, the rectus femoris participates in the bending of the lower pelvis.

The sartorius is the longest muscle in the human body. It starts in the pelvis and wraps around the front of the thigh to attach to the medial side of the tibia. It is partly responsible for abducting, flexing, and laterally rotating the hip, and flexion of the knee (fig.06b).

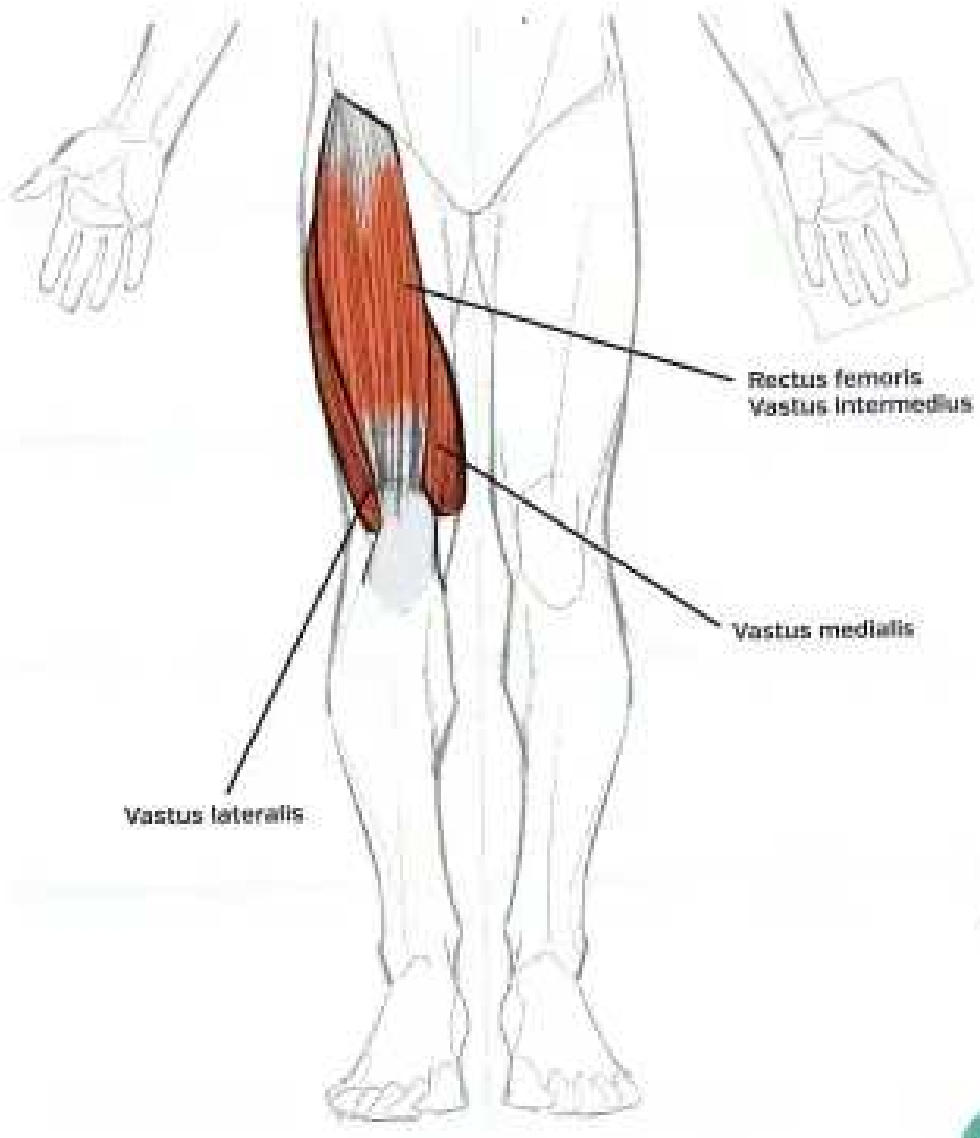
Then there are the adductor muscles (adductor magnus, adductor brevis, adductor longus, gracilis, and combl. They all originate from the pubis and



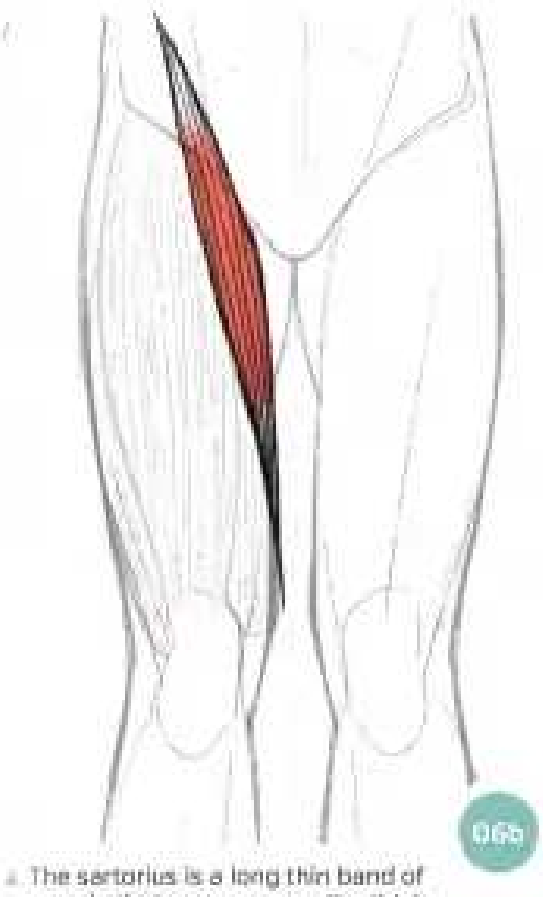
▲ The flexor carpi radialis moves diagonally down from the elbow to the hand



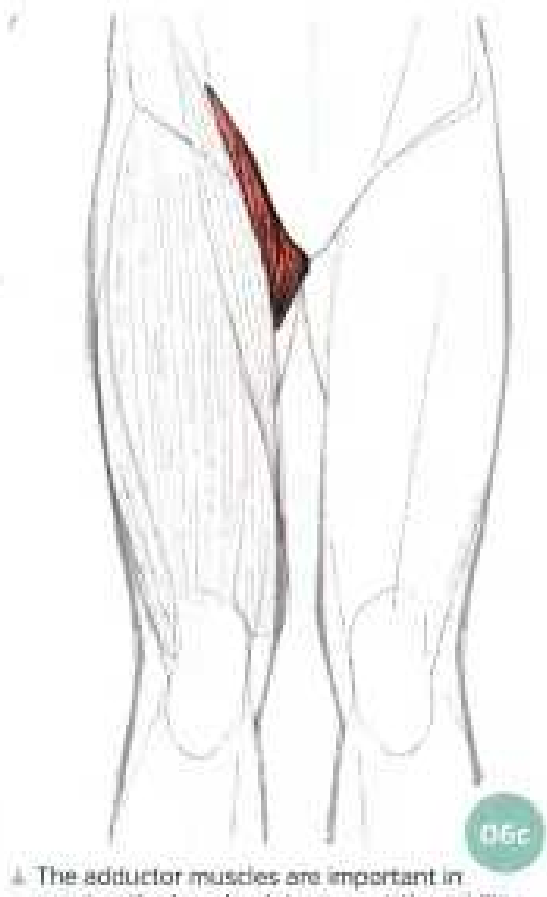
▲ The brachioradialis allows the flexion of the forearm



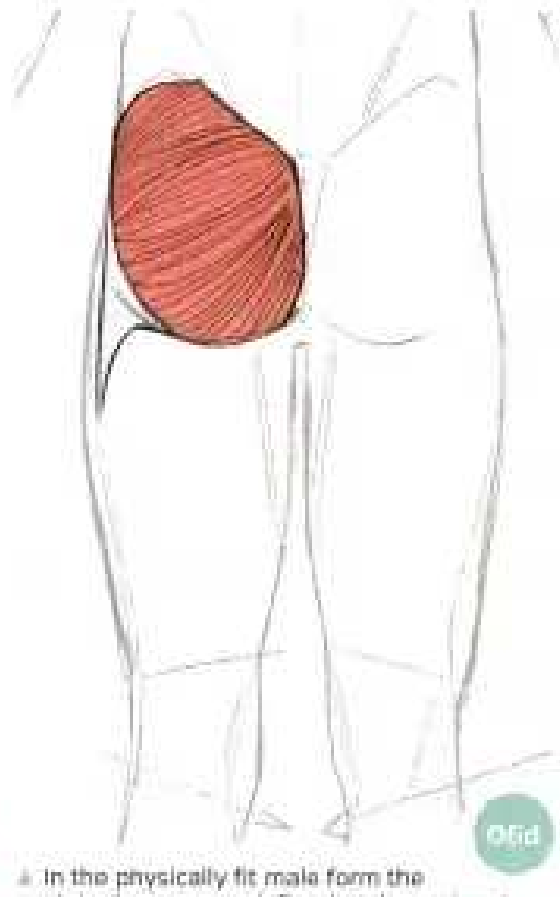
▲ The muscles that make up the quadriceps



▲ The sartorius is a long thin band of muscle that wraps across the thigh



▲ The adductor muscles are important in moving the legs back to or past the midline



▲ In the physically fit male form the gluteals are more defined and prominent

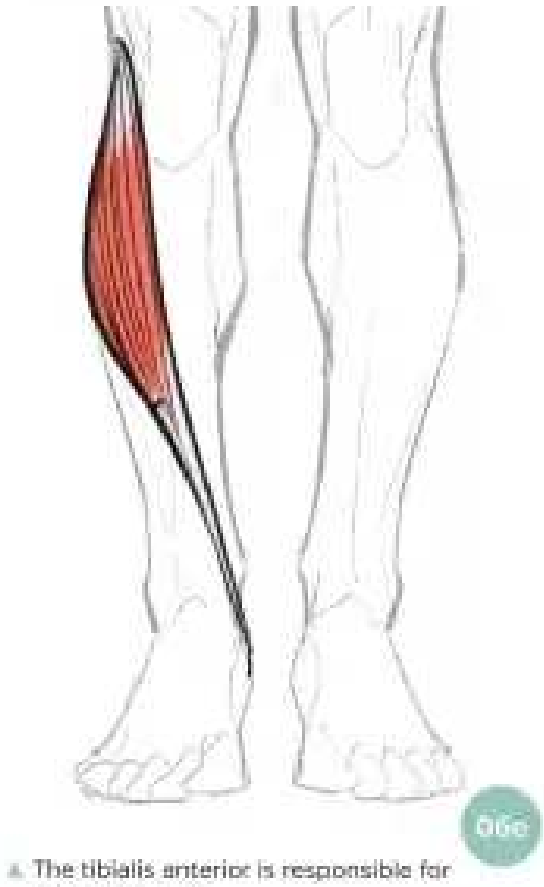
fit, with the exception of gracilis, on the linea aspera, a bony ridge present along the posterior surface of the femur. All adductors determine adduction and flexion [fig.06c].

> "The medial head of the gastrocnemius muscle is prominent in the front view of the leg"

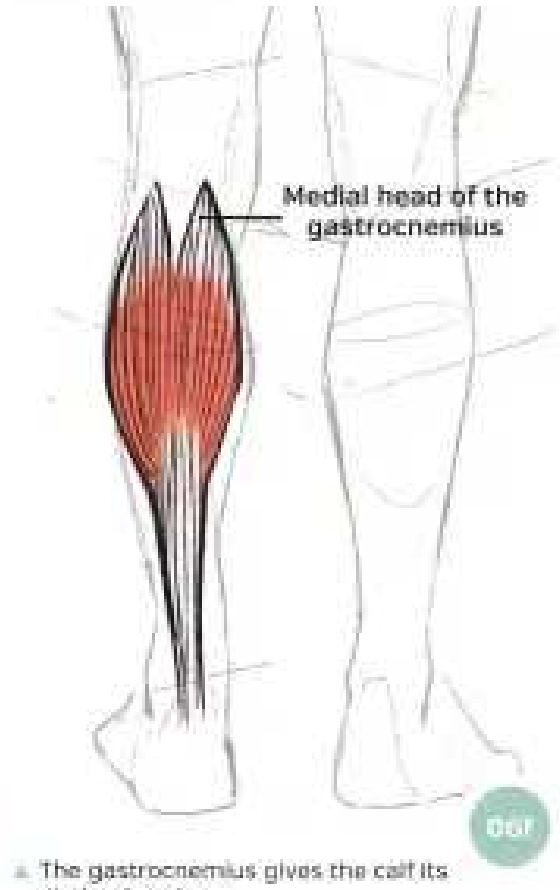
The muscles that make up the back of the upper leg are the biceps femoris, semitendinosus, and semimembranosus. However, they tend not to have a defined shape and will not greatly impact the overall shape of the model.

The gluteals are made up of three separate muscles [gluteus maximus, medius, and minimus] of the buttocks. They are the largest and strongest of the muscles in the human body. In a very fit physique they contribute to the overall shape whereas an individual with more body fat will have a rounder, smoother silhouette [fig.06d].

The tibialis anterior originates at the lateral side of the knee and crosses over the middle of the leg, finding insertion on



▲ The tibialis anterior is responsible for flexing the foot



▲ The gastrocnemius gives the calf its distinctive shape

the first metatarsal bones of the foot. It is mainly responsible for flexing the foot by pulling on its upper surface [fig.06e].

The medial head of the gastrocnemius muscle is prominent in the front view of the leg; it is this muscle which gives the lower leg its distinctive shape. The gastrocnemius or calf muscle is the large muscle on the back of the leg [fig.06f]. It is responsible for moving the body forward when walking, by pushing off the ground in order to create forward momentum.

The two heads join together half-way down the lower leg and form the very strong Achilles tendon. See more on the muscles of the feet on pages 149–150.

Drawing an archetypal figure

2D male

Part 04 | Skin, contours, and details

By Laura Braga

Comic artist and illustrator

Having studied the proportions, bones, and muscles in the previous three parts, we now have sufficient knowledge to work on our model and complete it in full, finishing it with the skin, natural curves, contours, details, and highlights. This will therefore be the last part of this chapter.

We will draw from the information in the previous parts and finalize our mannequin with curves and details, to get to the finished design of our model. This is probably the most enjoyable phase of the work because you can use your imagination to enrich the model with hair, facial features, and characteristics.

It is important to understand how important all the previous steps are at this stage. In fact, if we did not properly study the previous stages (proportions, skeleton, and muscle), it would be impossible to achieve a good result in the final phase and have a reasonable and realistic model.

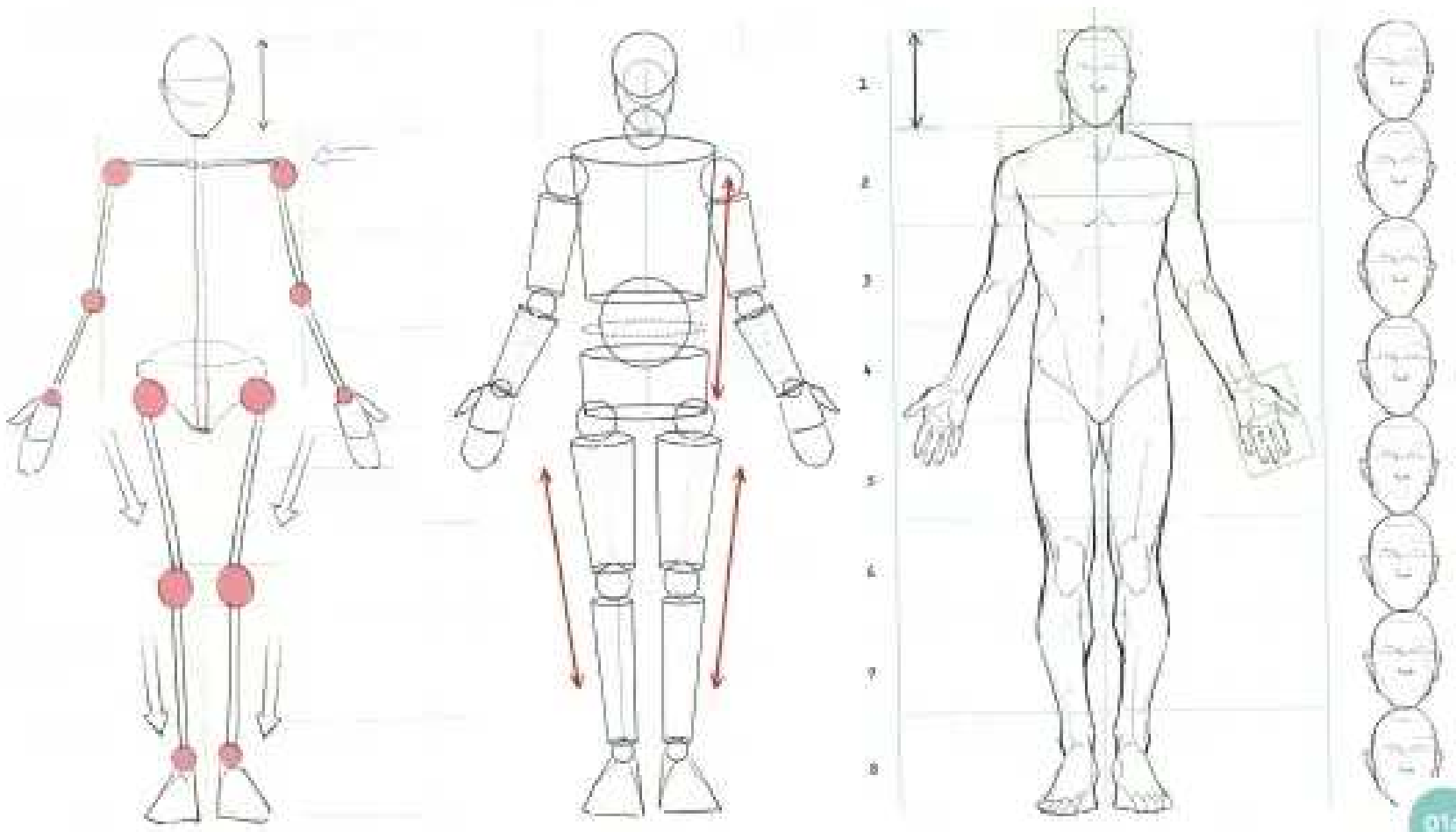
01: Skin

Using the front view of the body as an example, we will see how the model has already become developed and richly detailed. At this point we'll just finish the model with the skin, giving the right forms over the muscles. We can see how the figure is built up in layers if we put all the different stages of the figure together.

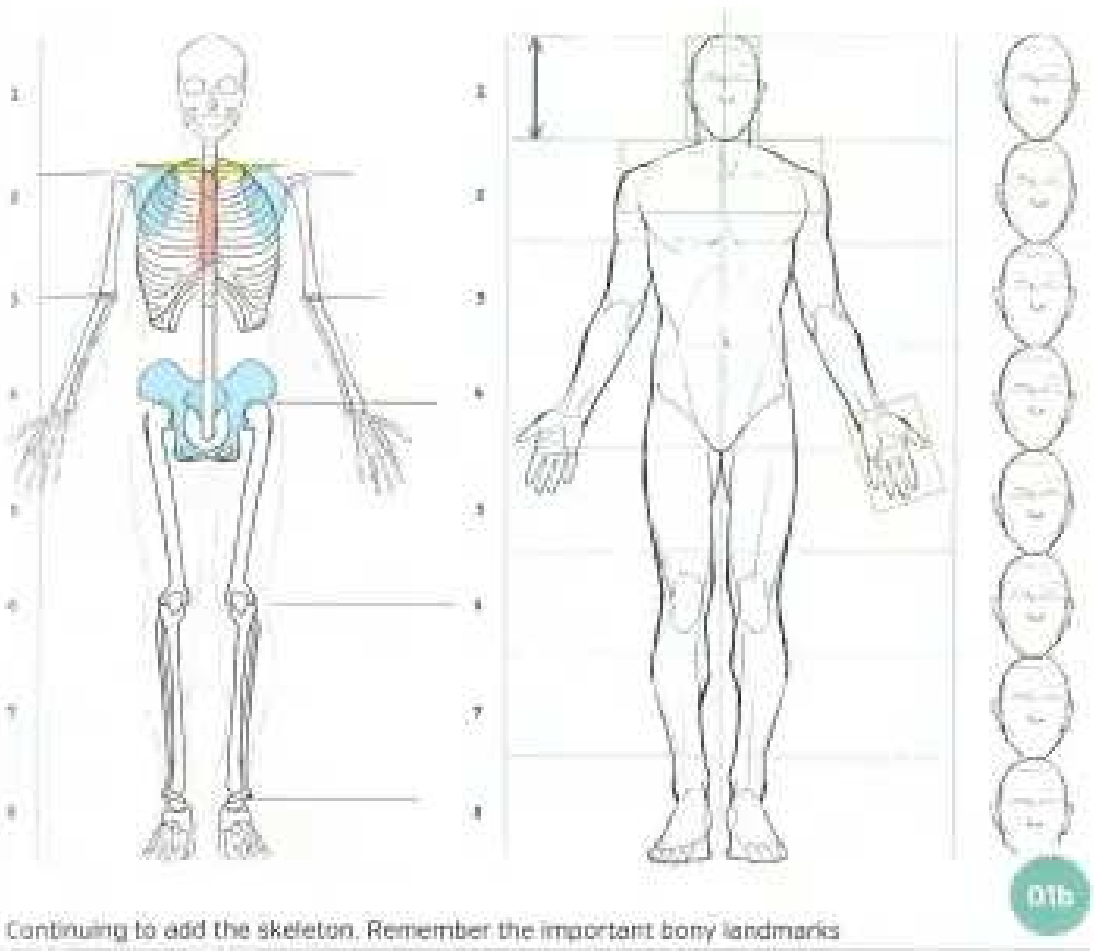
"Unless you are going for a bodybuilder look, the thighs will not be hugely defined; however, the calves should have a very distinctive bulge at the top half of the lower leg"

These stages together reinforce just how important it is to understand skeletal and muscle anatomy. It helps with designing a realistic and natural looking model. If we put them close to each other in sequence we will notice immediately that our model gradually takes shape and life (fig.01a).

It can be useful to place different parts of the skeleton over the top



▲ You can see the progress from our initial stick men to a finished sketch



01b

Continuing to add the skeleton. Remember the important bony landmarks

of the final outline; this helps with checking proportions and position of the bony landmarks (fig.01b; also see pro tip box on the next page).

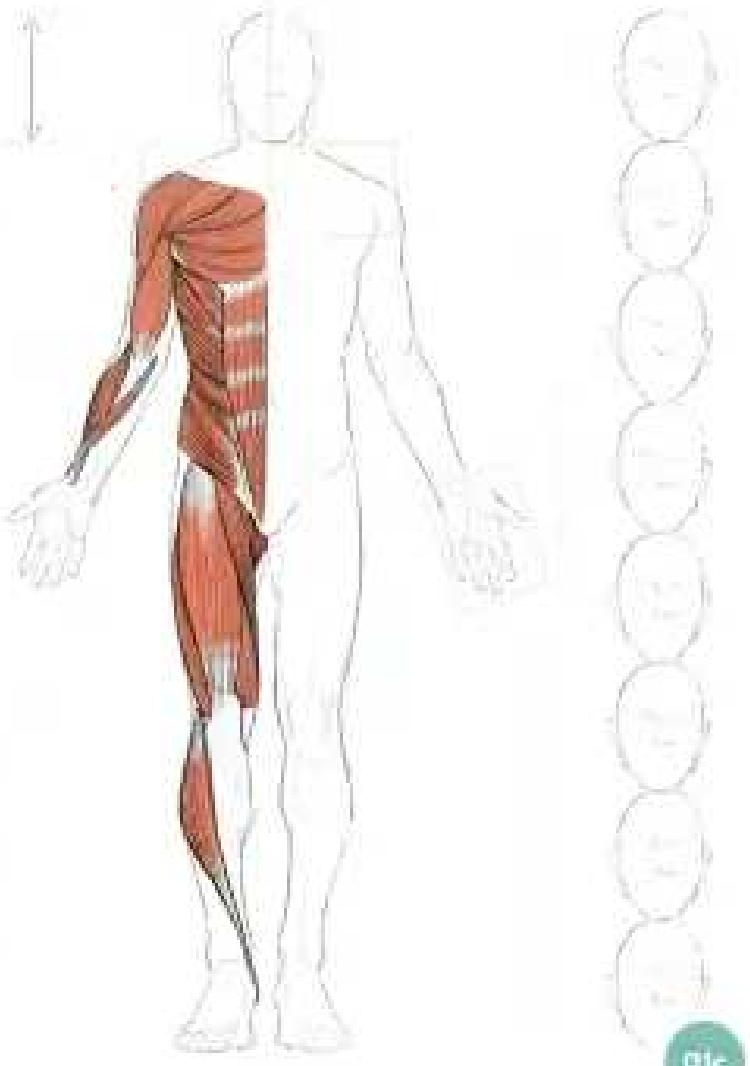
In the previous parts we looked at the muscles of the body and how they impact on the overall look and feel of the human form. In fig.01c and fig.01d we can see where the shape and placement of the muscles impact the silhouette and skin of the human form.

> "We have a blank canvas with which to really give the model some personality. This is where we can let our imagination take the reins"

From the front we can draw the lines that will define the clavicles, chest, and nipples; also in the trunk, we can see how it will be easy to define the forms of the abdomen.

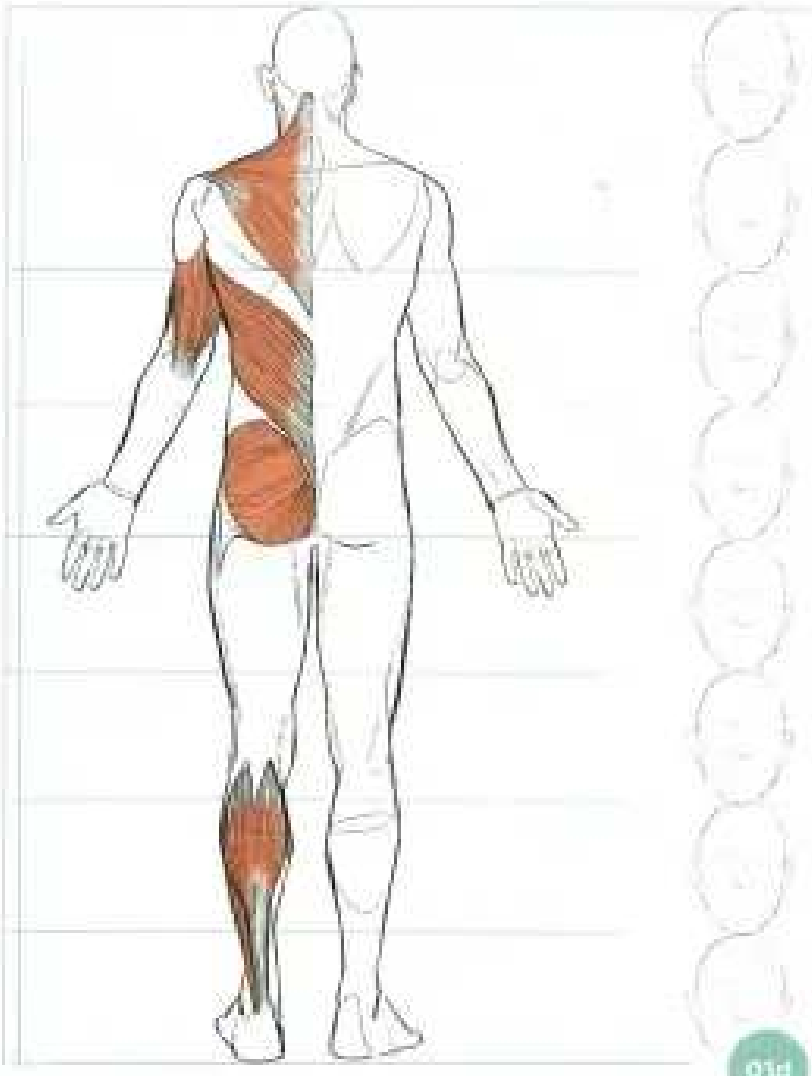
As for the arms, we can define the very important deltoid muscle which gives shape to the shoulders. By drawing in the elbow joint, we get a better understanding of the direction and movement of the arms. It is also important to get the wrist right.

Unless you are going for a bodybuilder look, the thighs will not be hugely



01c

Muscles on the front of the body



01d

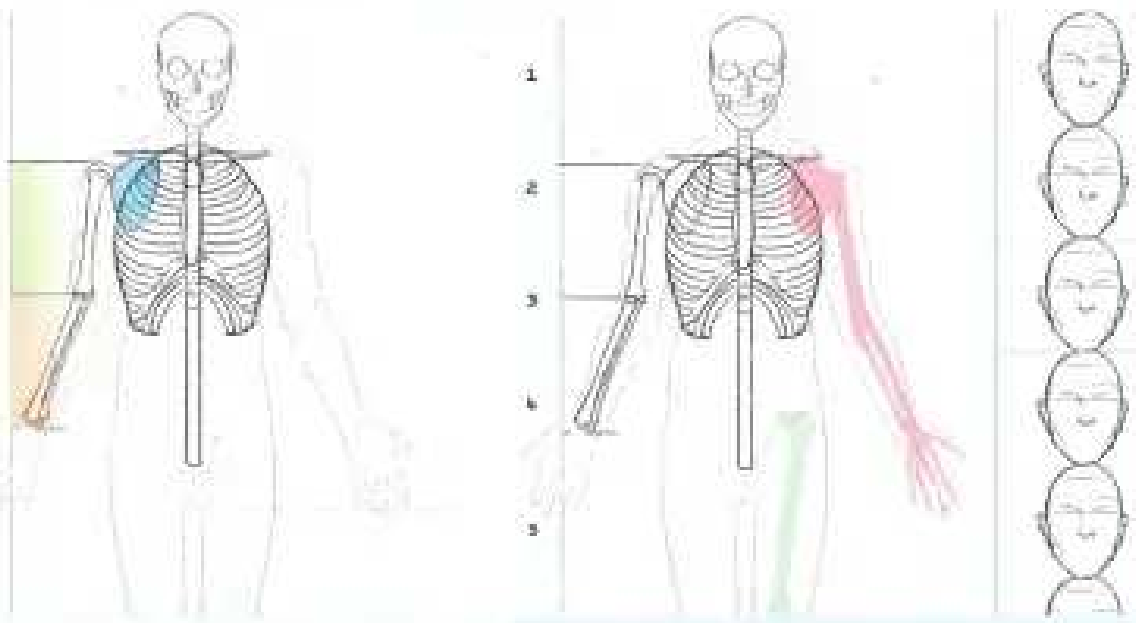
Muscles on the back of the body

PROTIP

Work in sections

It is better to work with one area at a time and gradually add the different parts until you have the whole skeleton added.

This is the same for any anatomical drawing, whether it is done in 2D or 3D



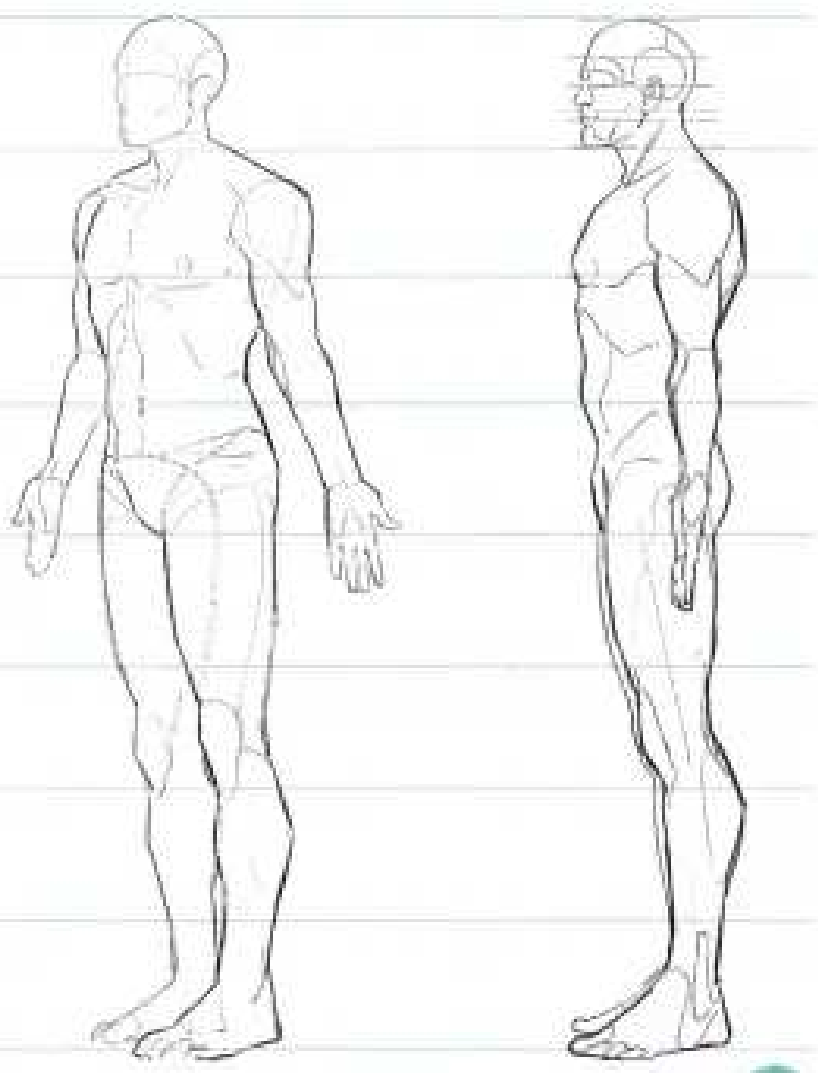
▲ Adding the key features of the skeleton to make sure we have the correct proportions

defined; however, the calves should have a very distinctive bulge at the top half of the lower leg.

Lastly we can add definition with lines to the areas of the knees and ankles. It is vitally important to look at your references from all angles in order to fully understand how the human figure looks, especially if you are working in 3D [fig.01e].

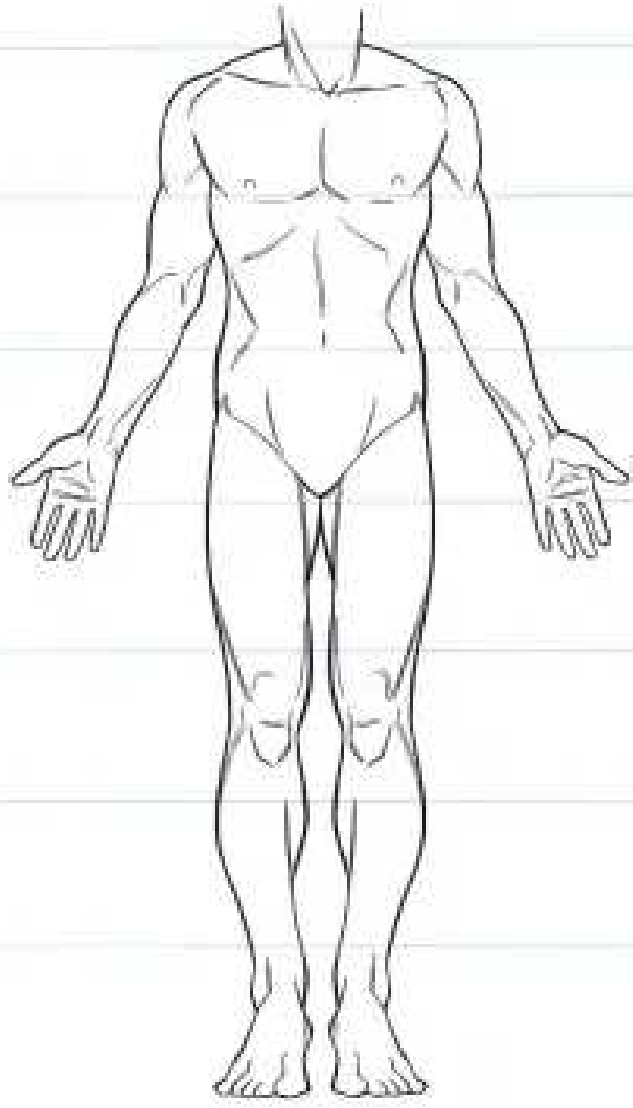
To make our model more realistic, we can soften and smooth the contour lines and add little details such as the belly button and nipples [fig.01f].

"Much of what you decide to use will depend on the purpose of the model. For example is he an honest hero with large open eyes or a shady villain with small beady eyes?"



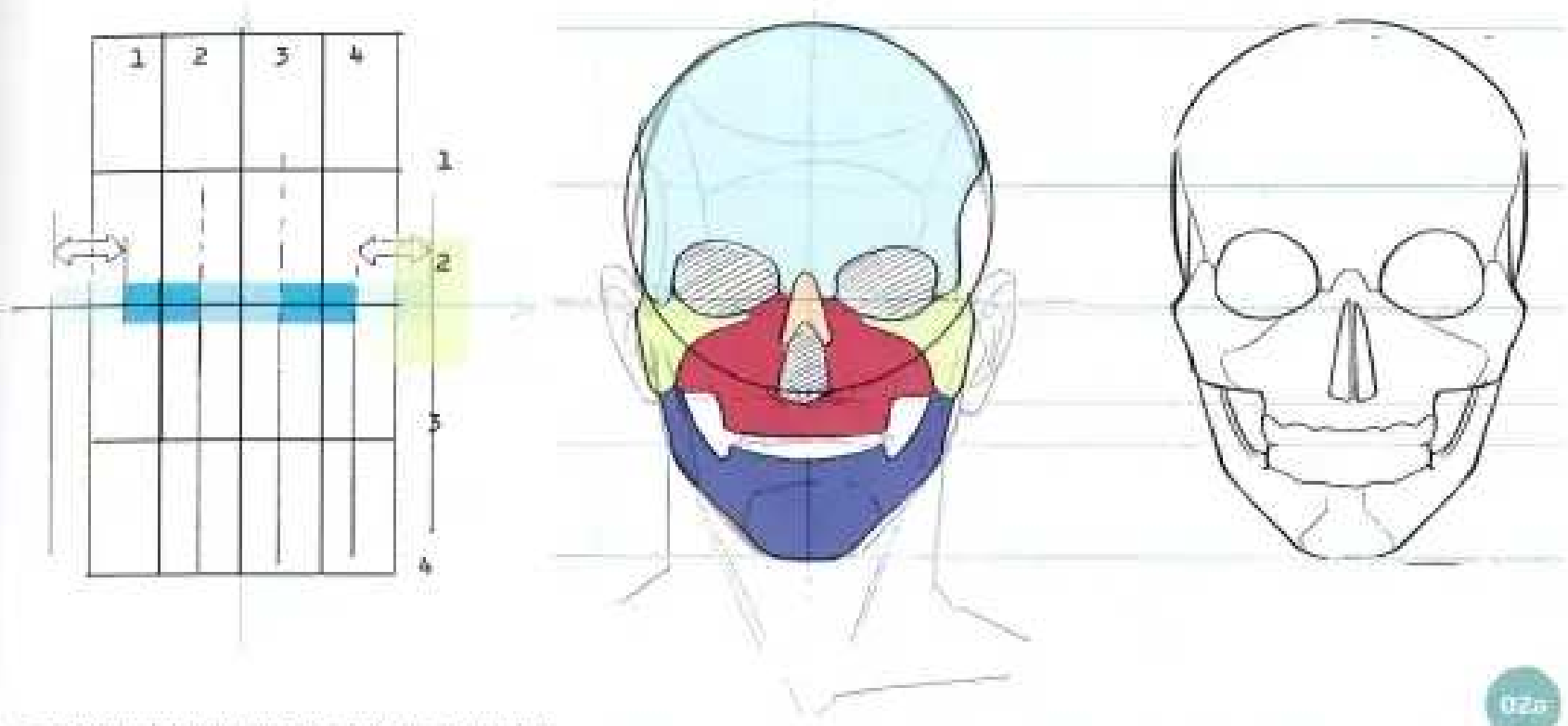
01e

▲ ¾ and profile view



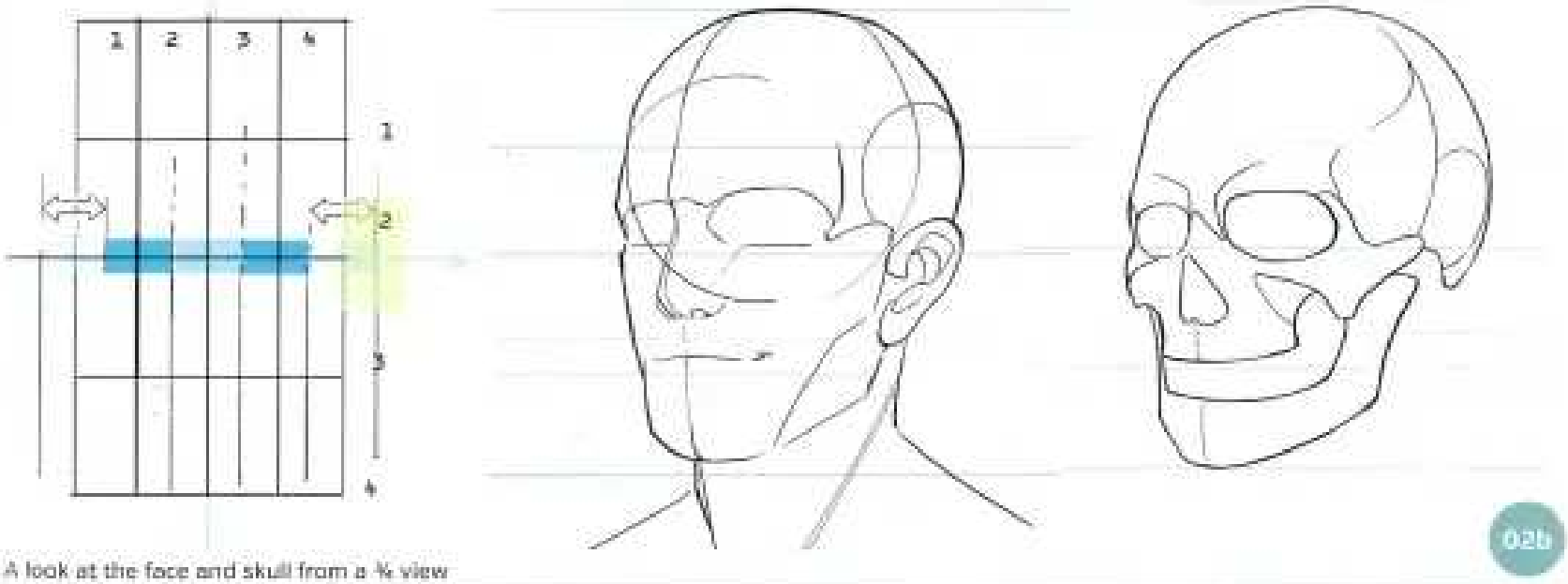
01f

▲ The final figure with correct proportions, muscles, and skin



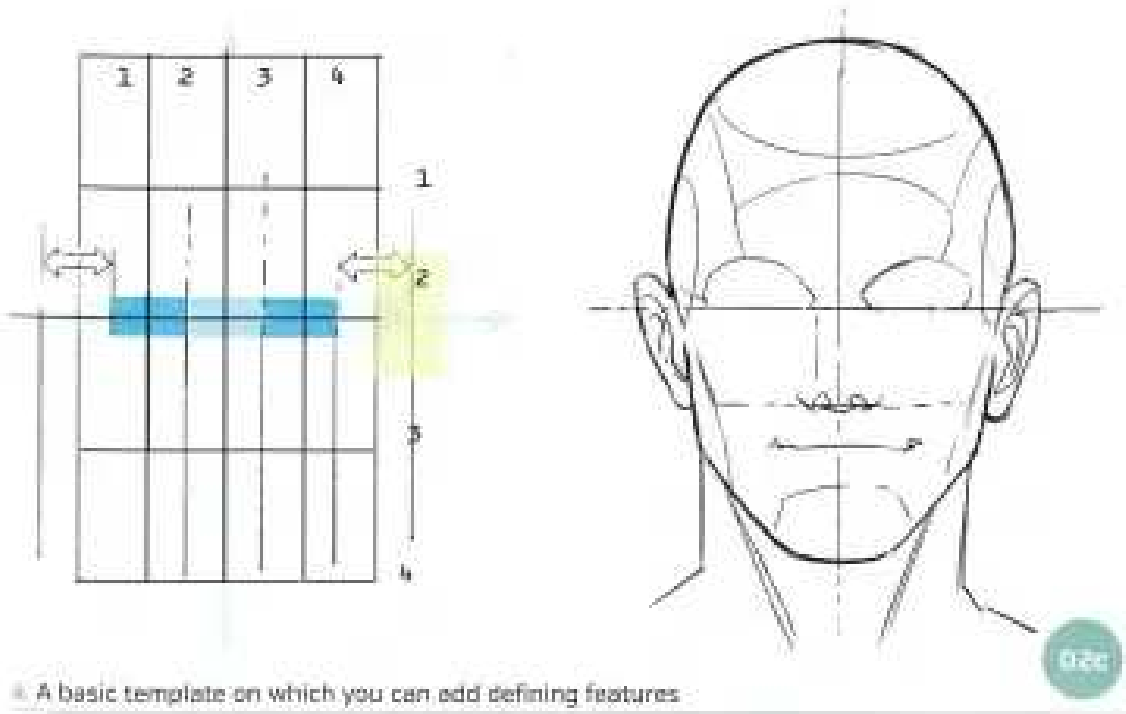
02a

A A reminder of the proportions of the head and skull



02b

A look at the face and skull from a ¾ view



02c

A basic template on which you can add defining features

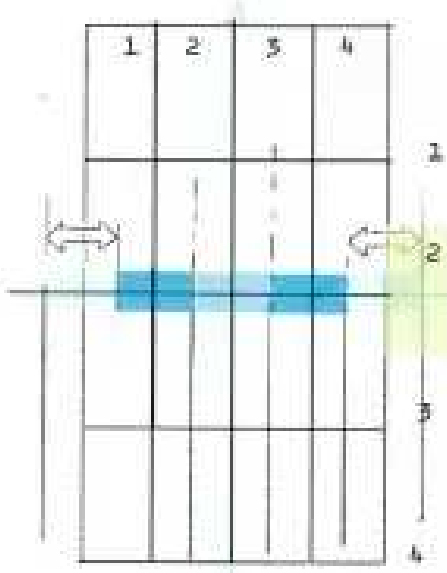
02: Head

If we look back at the head from part 02, we can see that we already have a basic outline of the face. From this it will be easy to add the details [fig.02a]. It is always good to look at the head from different angles to make sure that the proportions and placement are correct from all angles. Again, this especially important when working in 3D [fig.02b].

We have a blank canvas with which to really give the model some personality [fig.02c]. This is where we can let our imagination take the reins. We can either copy reference images exactly or mix and match to make a unique face.

There are so many variations of all the different facial features that we could come up with multiple faces based around a few different features. Much of what you decide to use will depend on the purpose of the model. For example is he an honest hero with large open eyes or a shady villain with small beady eyes?

For reference I have sketched up three similar faces that are subtly different from each other. Fig.02d has a thinner nose and mouth, with friendly, curved eyebrows. Fig.02e looks villainous with his bunched forehead and slight smirk. He has a wider bridge and tip of the nose, more angled eyebrows, and fuller lips. Fig.02f has a rugged, broken nose and straighter lips. Try to choose features that reflect the story and personality of the character.



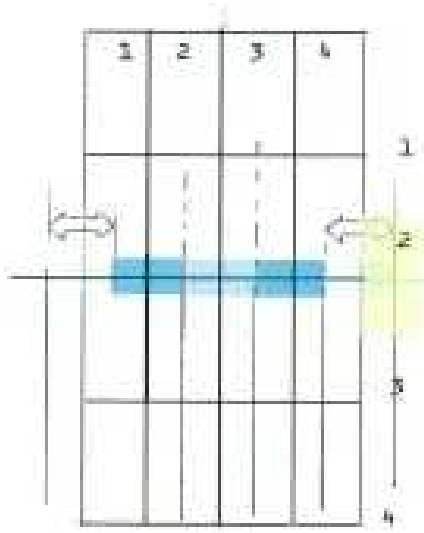
▲ A neutral open face with thin facial features

03: Hands and feet

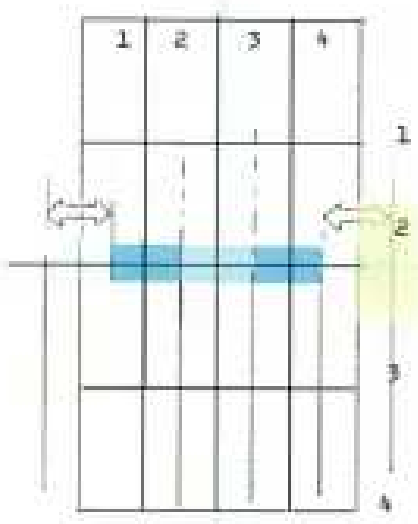
Hands and feet are notoriously difficult to get right; a lot of people make the mistake of making the hand rigid with the fingers splayed and dead straight. If you look at your hands when they are in a neutral or resting position, you will see that they are quite floppy and the fingers fall together in a gentle curve. For the purposes of this book I have drawn the hands of my models splayed out. This is because it is important to get the correct proportion and position of the bones before we move on to creating a relaxed pose.

Try to remember these important points about the hands. Each finger has three joints (knuckles), except the thumb which only has two. The one at the base of the finger is more prominent when the hand is clenched. The skin is wrinkled and folded at the other two knuckles; this allows the skin to stretch when the fingers are bent. The other thing to remember is the fingernails – they can make or break a good anatomy study (Fig.03a).

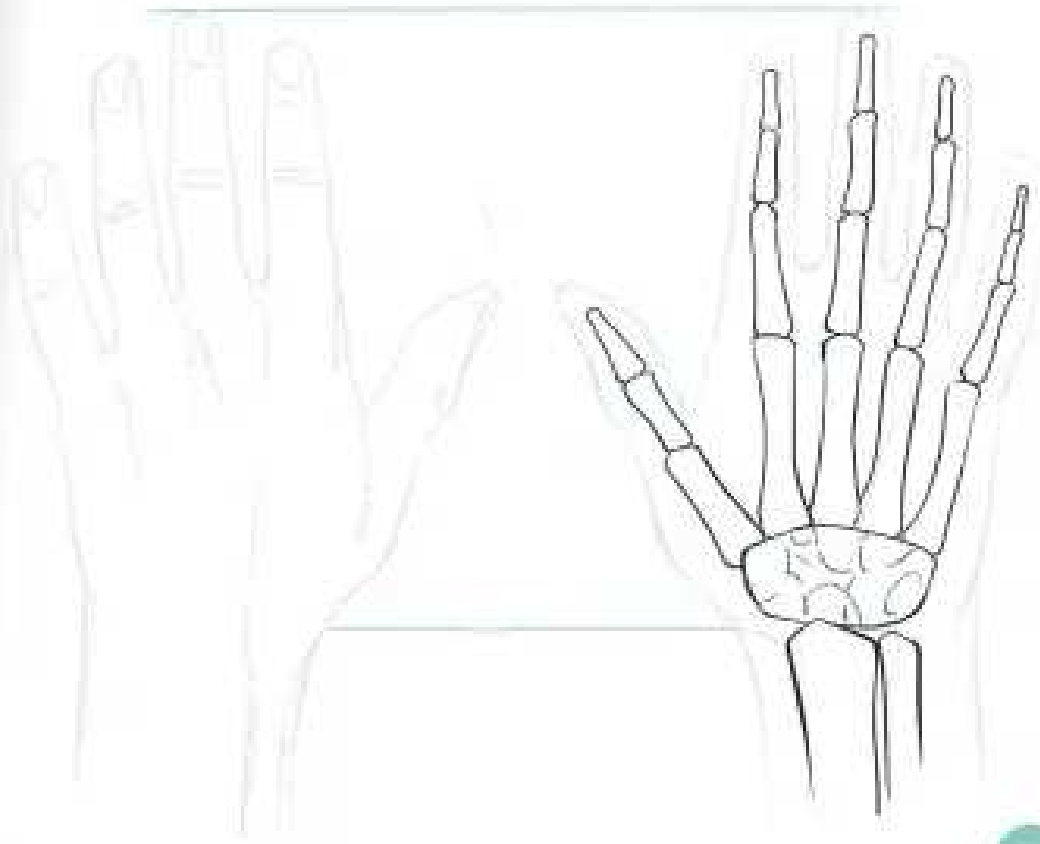
Structurally, the feet are constructed in the same way as the hands. However, they look quite different, especially because they are not able to pick things up – the bones are shorter and



▲ A more sinister looking character. His brow is furrowed in a scowl



▲ This face has a broken nose and straighter lips



03a

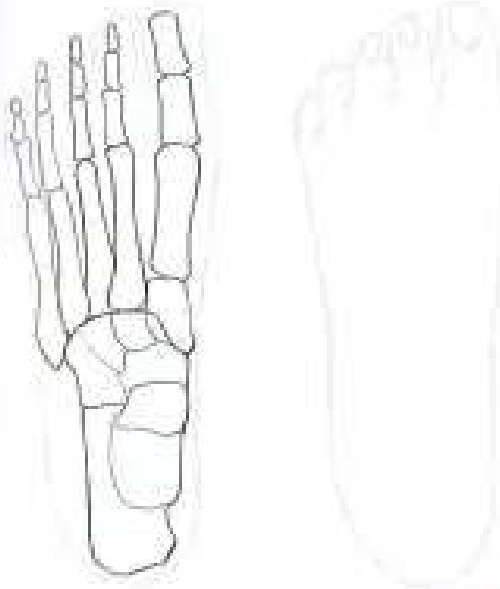
▲ Dorsal (upper side) and palmar (palm side) views of the left hand

positioned closer together. Usually you can only see the joint which is closest to the tip of the toe. Again, don't forget the toenails (fig.03b, fig.03c)!

04: Hair and ear

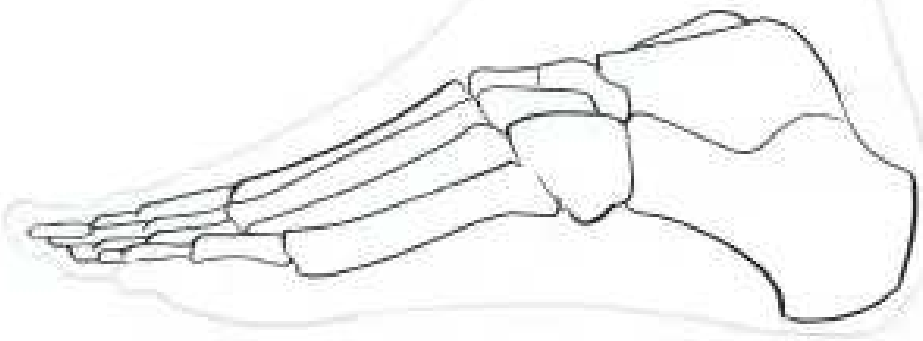
Hair can also change the overall look of a character. Again, a lot depends on the purpose and story of the character. Is he a college student or a rebel, for example? Another thing that can add that little touch of believability is whether there are additional details, for example piercings, glasses, scars, tattoos, moles, freckles, and so on. I have given one of the faces from step 03 three different hair styles. Each gives the character a different feel and potential story (fig.04a, fig.04b, fig.04c).

The human ear has quite a complex appearance and therefore can be



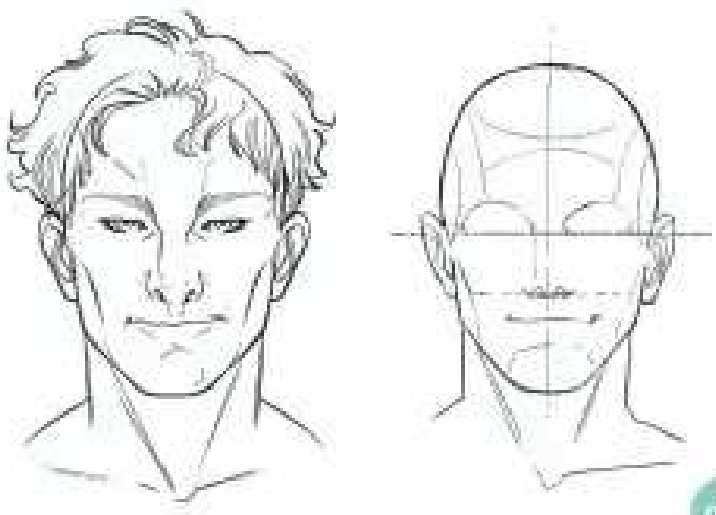
03b

▲ Dorsal view of the left foot



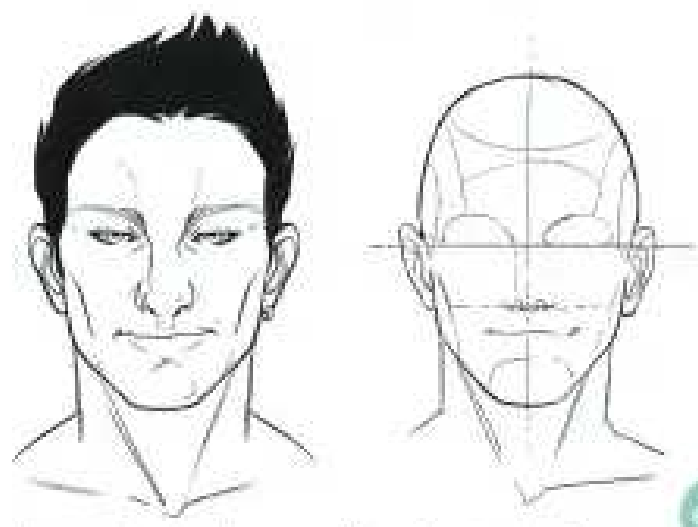
03c

▲ Side view of the foot showing the position of the foot bones



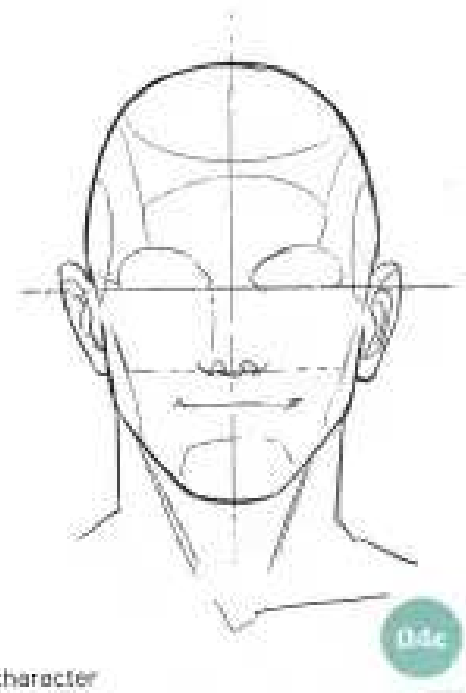
04a

▲ Adding hair can help to finish off a character



04b

▲ To add extra depth to the personality, add extra touches



▲ Different hairstyles can create different looks for your character

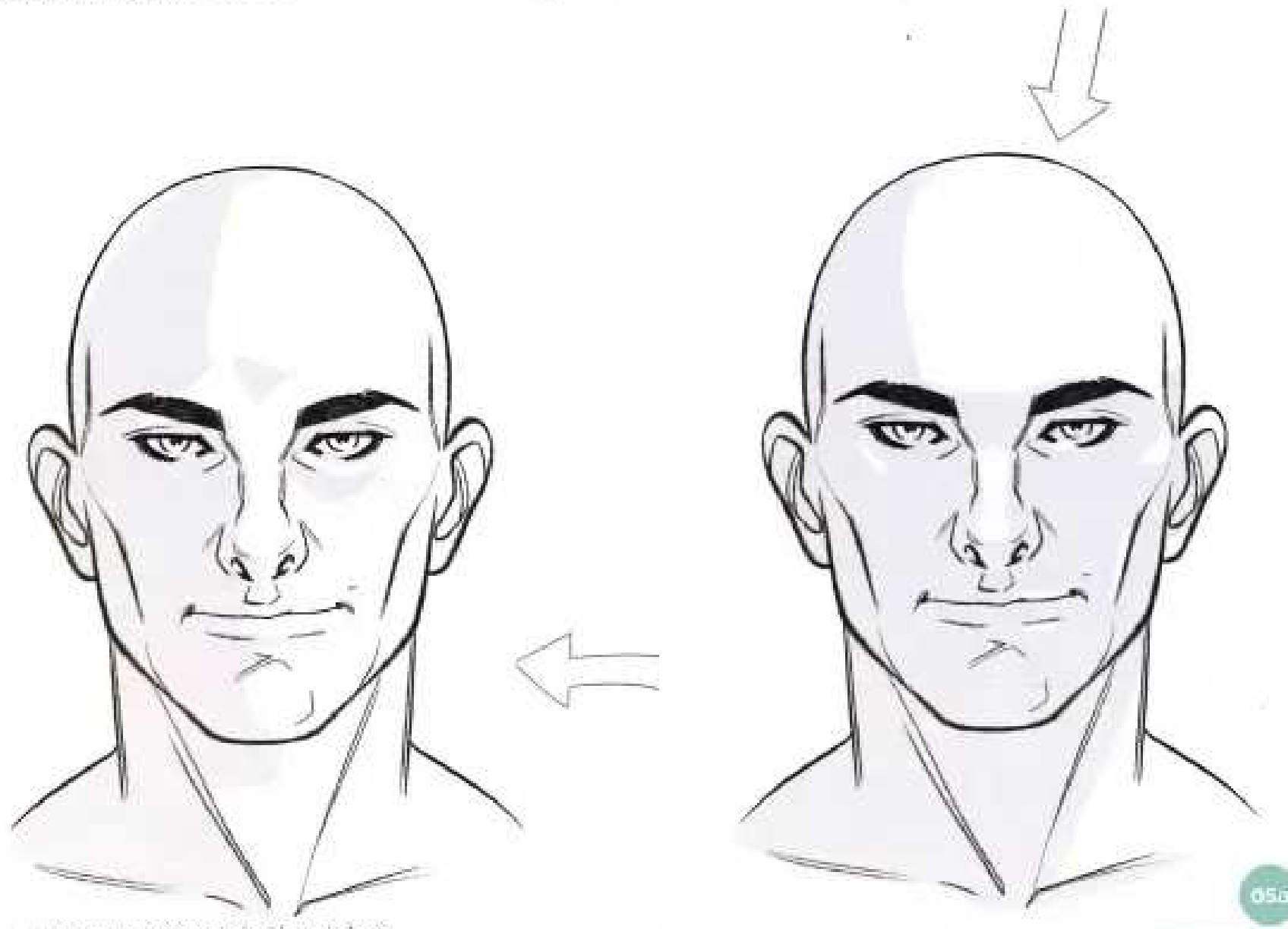
▲ Details of the human ear

difficult to get right. Often it can be overlooked, especially if the model has long hair which covers the majority of the ear details. However, I highly recommend that you learn how to represent an ear accurately because it is doubtful you will always just be producing long-haired models!

The auricle is the external part of the ear and is formed by the pavilion and the ear canal. The pavilion is made from a thin plate of cartilage covered with skin. It is therefore important for us to study the curves and the characteristics of the ear very carefully. As you can see from fig.04d, its external surface is not flat, but has an unequal oval shape and a very irregular surface with grooves and depressions.

05: Lights

Adding shadows and lighting to the character will enable you to add an extra sense of perceived volume and mass.

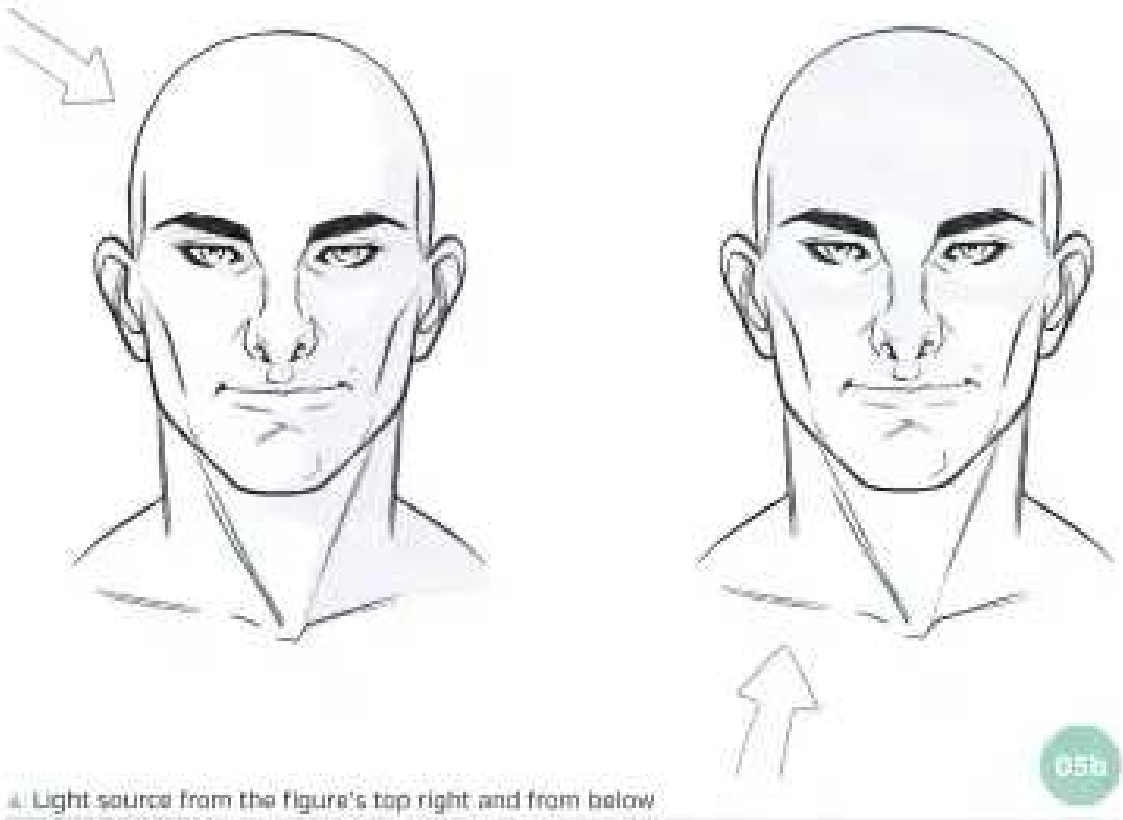


▲ Light source from the left side and above

This is true whether you are sketching on paper or using 3D software.

Chiaroscuro [meaning "light-dark" in Italian] is a technique used by artists to give an object or person three-dimensionality through the use of a clear contrast between light and dark. It is useful when studying anatomy because the high contrast clearly shows the volume and mass of the body parts.

Usually this technique would require plenty of study to be utilized in full, but in this case we only want to use it to help us appreciate the shadows and highlights on the human form.

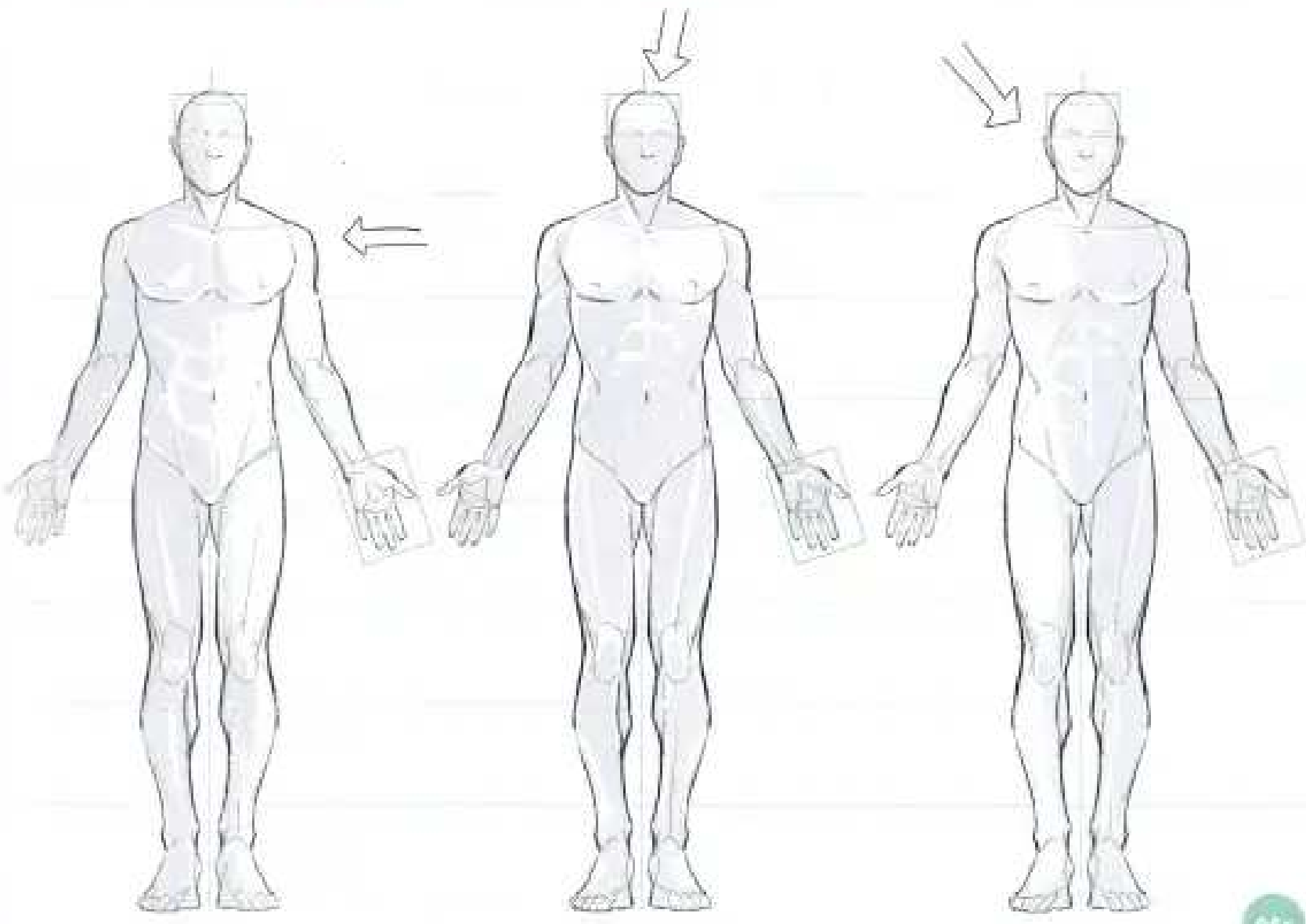


05a

4 Light source from the figure's top right and from below

Imagine a hypothetical light source. If we start with the head as an example, we need to imagine how the light source would illuminate the face and how it would create areas of shade on the muscles and facial protrusions [nose, lips, and arched eyebrows]. Looking at the different light sources shown in fig.05a and fig.05b, we can better understand how the highlights and shadows behave based on varying points of light. You can see the same method used in the context of the whole figure in fig.05c below.

Obviously this is only a first quick study of shadows and lights, enough to get a feel for the overall look. Once you place the character into a scene you can do a more in-depth study of lighting.



05c

4 Different light sources on the full figure

Drawing an archetypal figure

2D female

Part 01 | Proportions and basic form

By Chris Legaspi

Concept artist and oil painter

The human body is a beautiful, complex, and extremely fascinating thing to study. In this chapter, we'll explore the female form in detail and how we can draw more accurate and life-like figures.

First we will examine the ideal proportions of the body and learn how the head is used as the main measuring unit for the entire body. Using the head helps in achieving accurate proportions for the body and more realistic-looking figures.

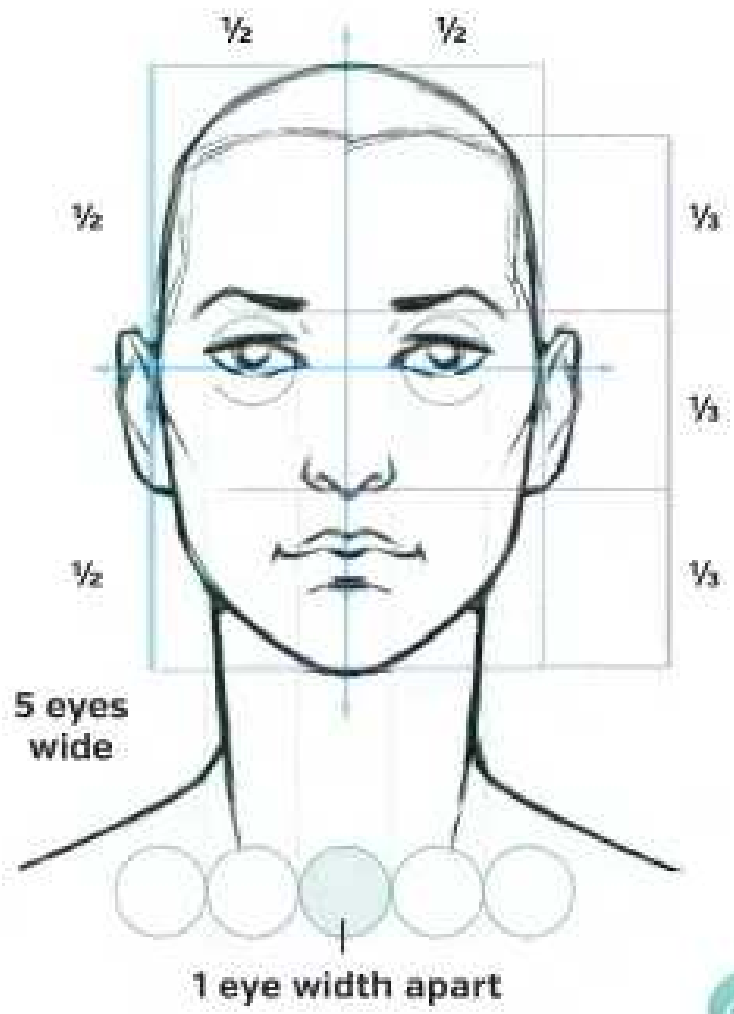
Next we will construct the head and full body. We'll examine the three orthographic views – front, side, and back – and how to construct the body using simplified, geometric forms.

Then we'll look at the rhythms of the body. Rhythms are naturally occurring lines in any organic form. We'll explore how they can be used to more accurately place anatomy and forms.

We'll finish the first part of this chapter by looking at gesture and movement. I find that in order to properly capture and study gesture the torso should be isolated from the whole. We'll look at the major parts of the torso and how gesture connects and relates these parts together. From this we can begin to construct the torso. We will examine the major parts of the torso and then build it using simple geometric forms such as cylinders, spheres, and boxes.

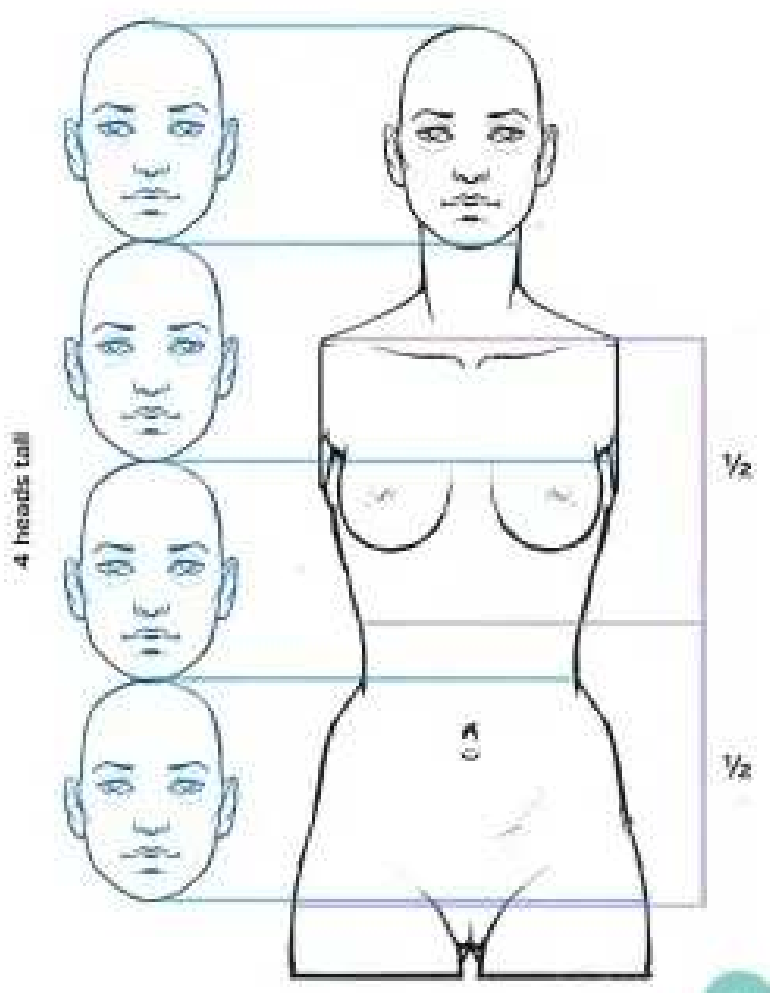
01: Proportions

Accurate proportions help us to achieve more a life-like and natural-looking figure. Since proportions vary from person to person, we'll define a set of proportions of an "idealized" female. This set is a generally accepted set of measurements that can be used and adjusted for any human body type.



01a

▲ Use the rule of thirds to construct a well-proportioned face



01b

▲ Use four heads for the length of the head and torso

02: Constructing the full figure

Since the head will be the major measuring unit for the entire figure, I like to first define the proportions of the head and face [fig.01a]. From the front, the head can be divided in half both vertically and horizontally. The vertical center runs through the center of the nose and the horizontal center runs through the eyes. To place the features, I divide the face into three even units by drawing a line through the hairline, brow ridge, bottom of the nose, and bottom of the chin. This measurement is known as the rule of thirds. Once the head is established I move on to the torso.

To get an accurate proportion for the torso, I start by measuring four heads from the top of the head to the bottom of the pelvis [groin area] [fig.01b]. To get an accurate length for the torso, I simply divide it in half starting at the top of the shoulders. The horizontal centerline also gives me the bottom of the rib cage.

Finally, to get proportions in the full body, I use a total of eight heads from the top of the head to the bottom of the feet [fig.01c]. As noted earlier, four heads will give us the upper body of the head and torso, and so the final four heads give us accurate proportion for the legs. The legs end at the bottom of the foot.

To construct the figure, I begin by refining the torso. Along with my three sections of rib cage, abdomen, and pelvis, I add the secondary anatomy. First is the abdominal wall which looks like a long flat rectangle shape. The female breasts can be easily constructed with the obvious choice of a sphere or rounded cone [fig.02a].

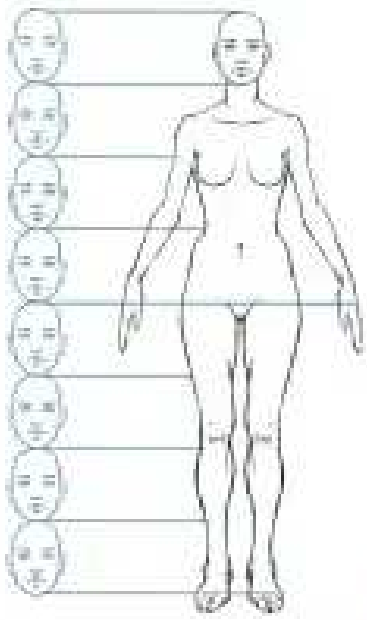
For the shoulder joint I use multiple layers of construction. I start with a tapered cylinder, as this shape groups the complex masses of the upper back. From the back and side views the cylinder also groups the latissimus muscle [fig.02b, fig.02c].

The next layer is a second cylinder for the shoulder joint. This includes the upper pectorals, shoulder blade, and surrounding muscles. This cone shape works because it mimics the ball and socket nature of the shoulder joint.

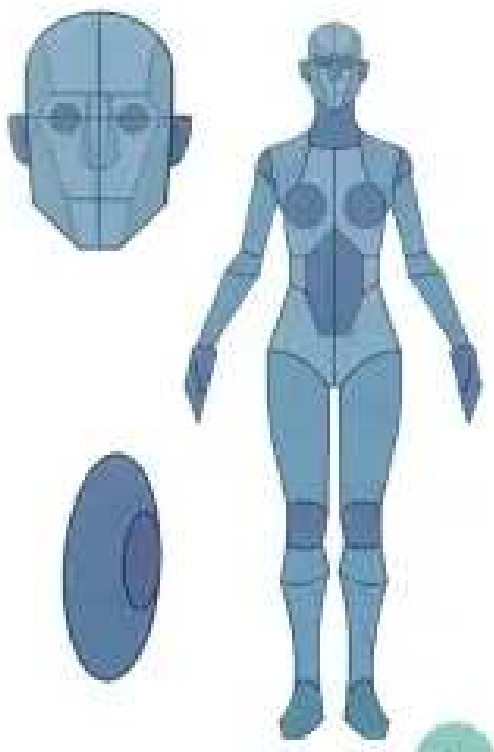
The final layer is the shoulder and upper arm. I use a simple sphere which fits nicely into the "socket" of the cylinder. The limbs in general can be simply captured with the obvious choice of cylinders.

To construct the head and neck I begin with a combination of a box and sphere, using an egg for the cranium and a box for the face. I like to use a box for the face because it allows me to define the front and side planes. The secondary details of the face like the brow ridge, eye socket, eyes, and nose can also be simply captured as boxes and spheres.

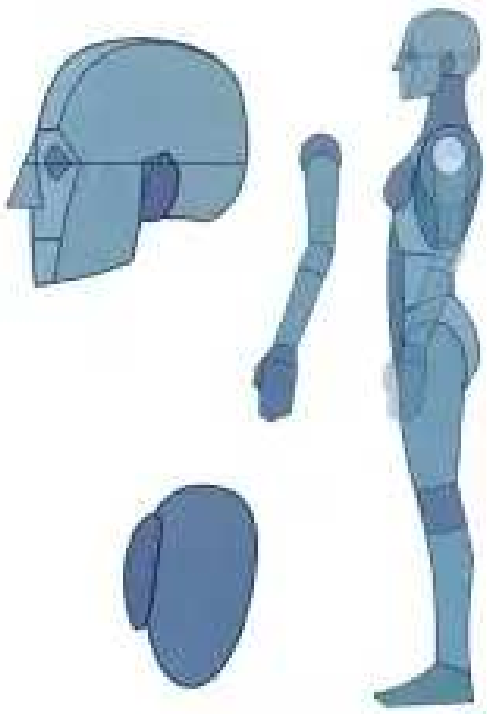
For the hands, I like a simple, tapered box or rectangle form. This neatly groups the fingers with the palm. For greater simplicity, a sphere can also quickly capture the hand and fingers. For the feet, the obvious choice is a triangular, wedge-like shape.



▲ The body can be measured as eight heads tall



▲ Front: refine torso shapes and use cylinders to construct the limbs



▲ Profile: the hands and feet can be made using boxes or spheres

▲ Back: more shapes to describe the complex anatomy of the back

03: Anatomical rhythms of the figure

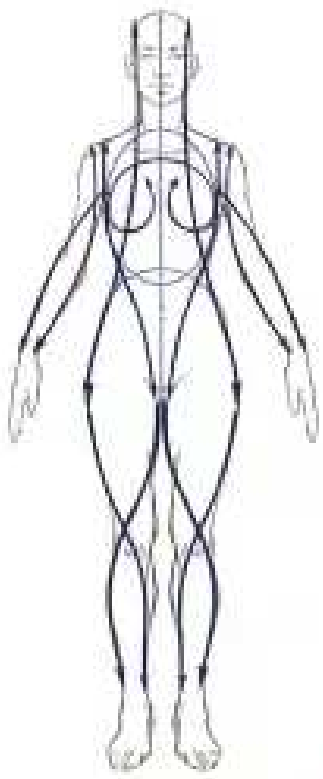
Rhythms are naturally occurring lines in the body (fig.03a). They are seen in the natural shape of bones, muscles, and connecting tissue. Rhythm lines lead the eye through the figure from one point of anatomy to another and back again. I use rhythm as a tool to help me accurately place anatomy on the body.

From the front, the major rhythm I see is from the neck down to the hips, naturally leading to rhythms down the leg, which help us place anatomy like the knee joint, thigh, and calf muscles. Note the rhythms from the shoulder to the crotch and many smaller rhythms in the torso and limbs.

Looking at the body from behind, I also note the major rhythm from the neck down to the hips. I note the way the anatomy of the upper arm flows from the shoulder to the wrist. The hips and gluteal muscles can be simply described in a rhythmic way (fig.03b).

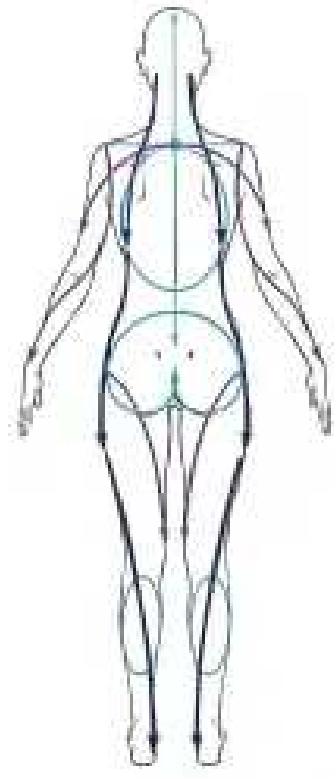
The face has many rhythms we can use. Because the face has many small shapes and forms and many complex details, rhythms are very helpful when placing features. From the front I note the rhythms of the brow structure. I note how the eyebrows (or eye sockets) flow into the bridge of the nose. The mouth can be described using a circular rhythm. I also describe how the ear connects with the chin using an elegant rhythm (fig.03c).

From the side, the major rhythm I note is the curve of the cranium and how many parts of the facial anatomy it intersects along its path. I also note the rhythm from the ear to the chin to help me place the mouth. The neck muscles naturally flow in a rhythm to the upper torso connecting the head and neck to the shoulders.



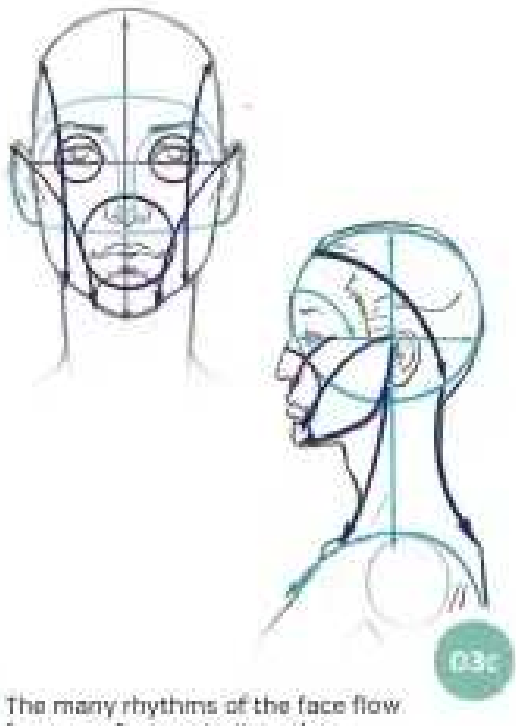
03a

▲ Rhythms occur naturally and are already designed into the body



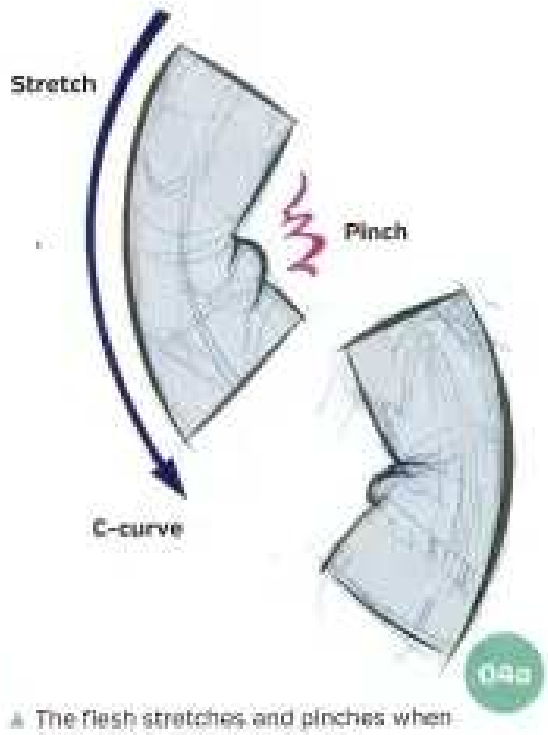
03b

▲ The rhythms flow from the head down to the feet



03c

▲ The many rhythms of the face flow from one feature to the other



04a

▲ The flesh stretches and pinches when the body flexes and extends

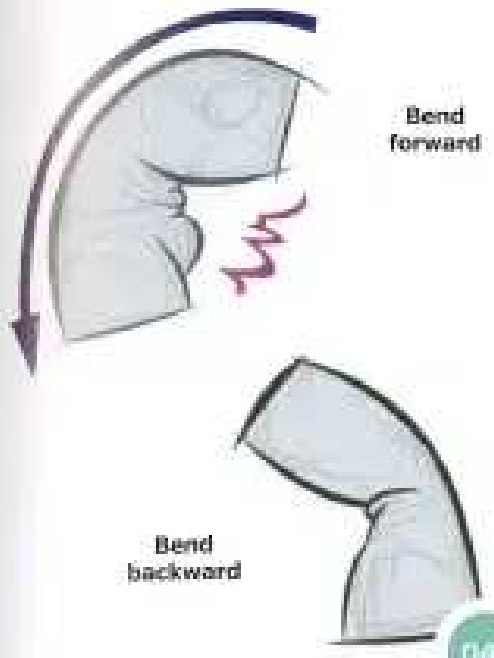
04: Gesture of the torso

Gesture is movement. It is the visual representation of life, the animation happening in the living human body. If we want our figures to look life-like, we must describe the gesture. Gesture is also the relationship between forms. It describes how one form moves or transitions into another.

When we look at the torso we can see the two major structures of the torso, which are the rib cage and the pelvis. How the rib cage interacts with the pelvis to create movement is the gesture of the torso.

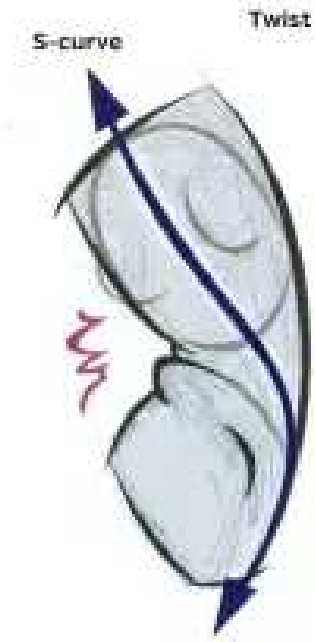
The first way the torso can move is bending to the side. When one side of the torso bends the muscles on that side relax and elongate. This is known as the "stretch". On the opposite side the muscles contract and collapse, moving the rib closer to the pelvis. This is known as the "pinch" (fig.04a). Because the human body naturally works in this way, we can quickly indicate movement and life by exaggerating the stretch and pinch.

The torso can also bend forward or backwards. To make a forward bend, simply exaggerate the pinching in the abdomen and relax the muscles in the back. This is especially noticeable when including the muscles and fat of the belly. To bend back, simply reverse



04b

▲ Remember the pinch and stretch when looking at extreme poses



04c

▲ Use a simple S-curve to capture the gesture of a twisting pose

05a

▲ Use a rounded cylinder to capture the ribs and abdomen and a box for the pelvis

the idea by relaxing the muscles in the front and creating contractions in the back muscles [fig.04b].

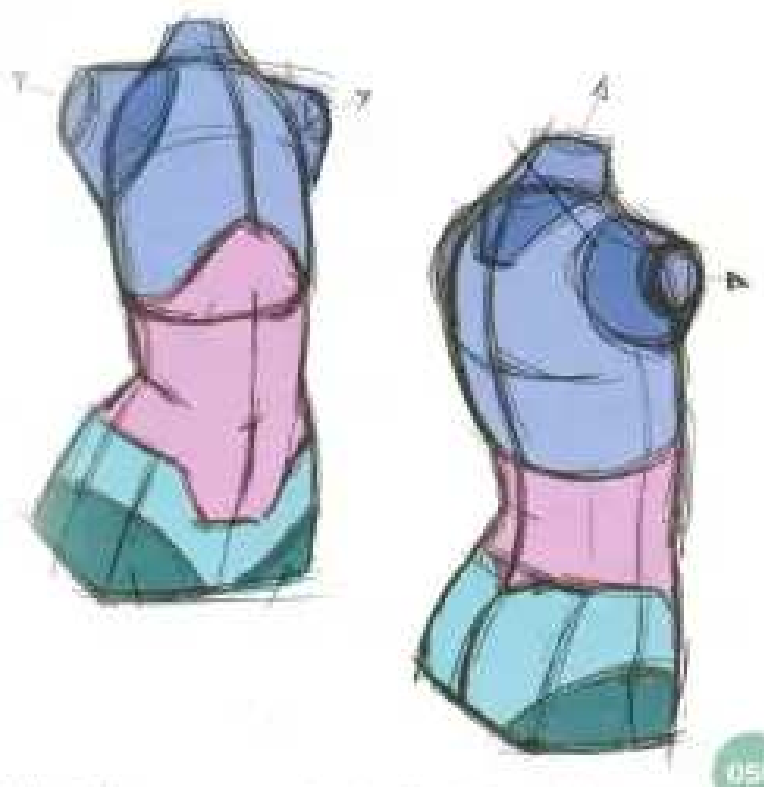
The final way the torso can move is in a twist. Twist is a combination of two stretched muscle groups moving in opposite directions. For example when the body is leaning straight back, simply turn the shoulders in either direction to create a twist. This can also occur with a simple rotation of the hips.

05: Constructing the torso

Construction is building the figure using hard rigid shapes and gesture is the movement of those shapes. To construct a figure, I like to start with the most simple geometric forms. The human body is very complex. Geometric forms give us the tools to manage this complexity. Of course, once we establish our simple forms we can add more detail and complexity as we draw or sculpt. The forms I use the most are cylinder, boxes, spheres, or any combination of them.

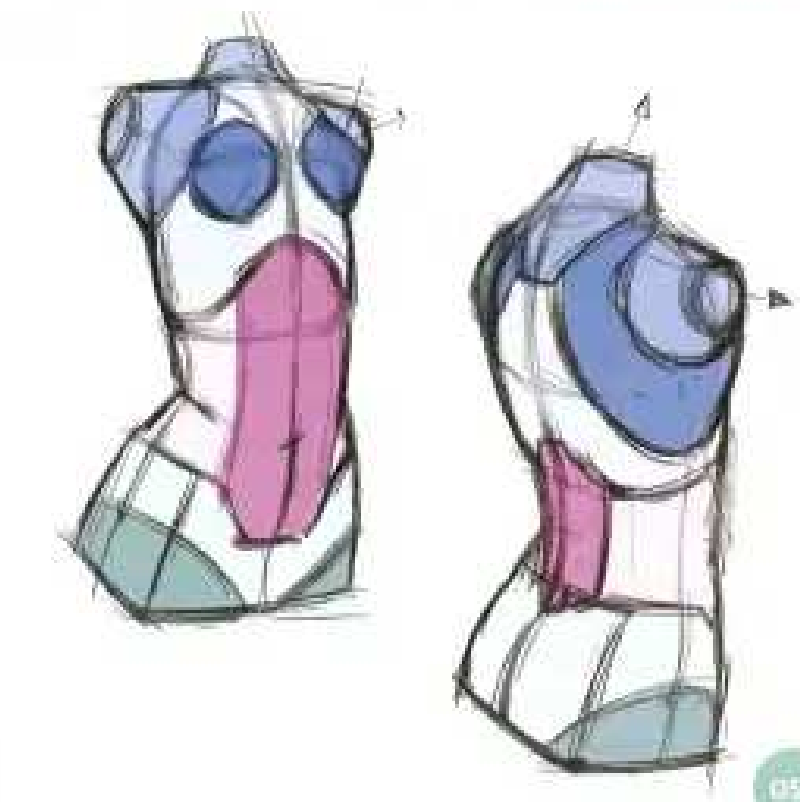
To construct the torso, I first simplify the torso into the most essential parts, which are the rib cage, abdomen, and pelvis. Instead of drawing the complex details and anatomy, I use geometric forms to capture the shape and essence of the torso forms. For example I use a rounded cylinder from for the rib cage. This form's shape resembles a large bullet or a birdcage. For the abdomen, I use either a cylinder or a box depending on the pose [fig.05a].

The abdomen is more fluid than rigid, so I can use various flexible shapes. I like to use a box shape for the pelvis because it captures the rigid shape of the pelvic structure. You can use similar geometric shapes for other parts of the torso, such as cones or spheres for the breasts, as shown in fig.05b and fig.05c.



05b

▲ Add cylinders to construct the shoulder girdle and the neck



05c

▲ Add a flattened rectangle for the abdominals and sacrospinalis

Drawing an archetypal figure

2D female

Part 02 | Skeleton

By Chris Legaspi

Concept artist and oil painter

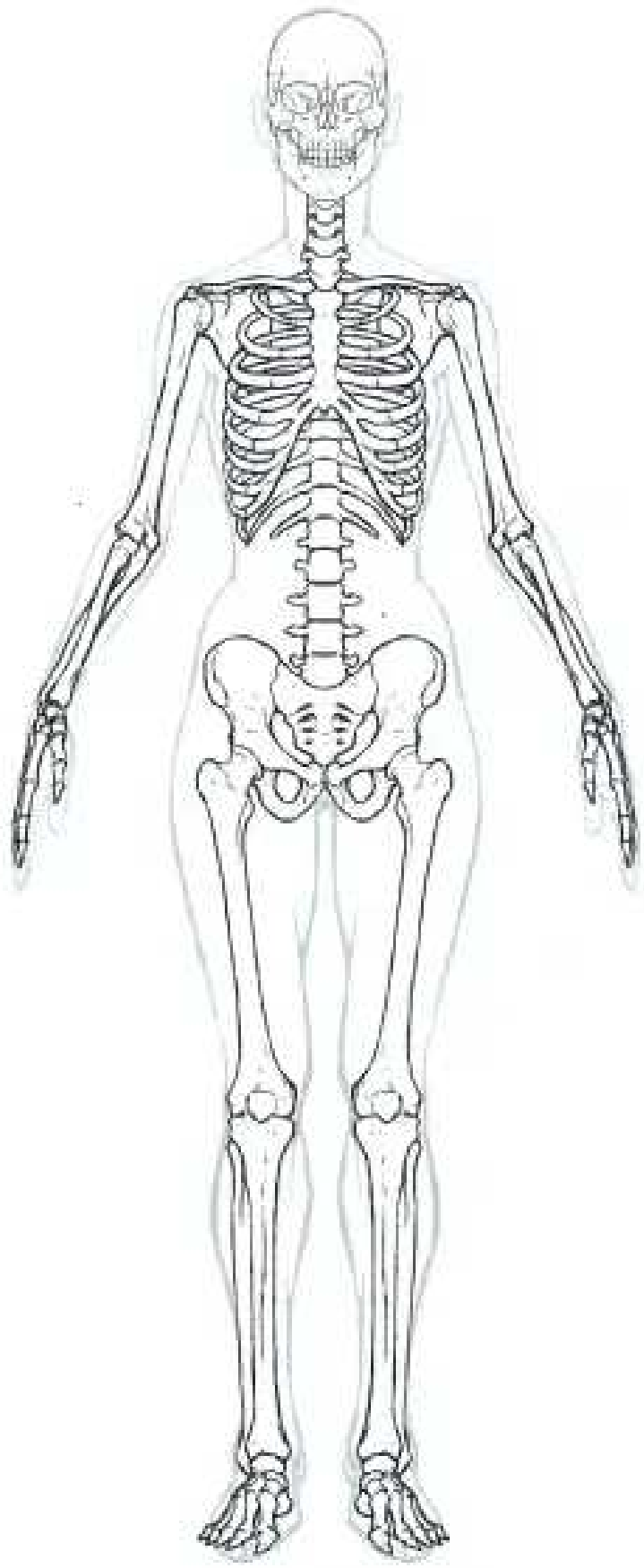
The skeleton is what gives the body structural integrity. Because the body is made of fluid, flesh, and organs, the skeleton serves to contain, protect, and hold the body and its vital organs. It allows for movement of the head, trunk, and upper and lower limbs. It holds the body upright and allows it to sit, stand, and walk.

"The spine is an intricate system of bones that contain and protect the spinal cord, the body's vital nerves"

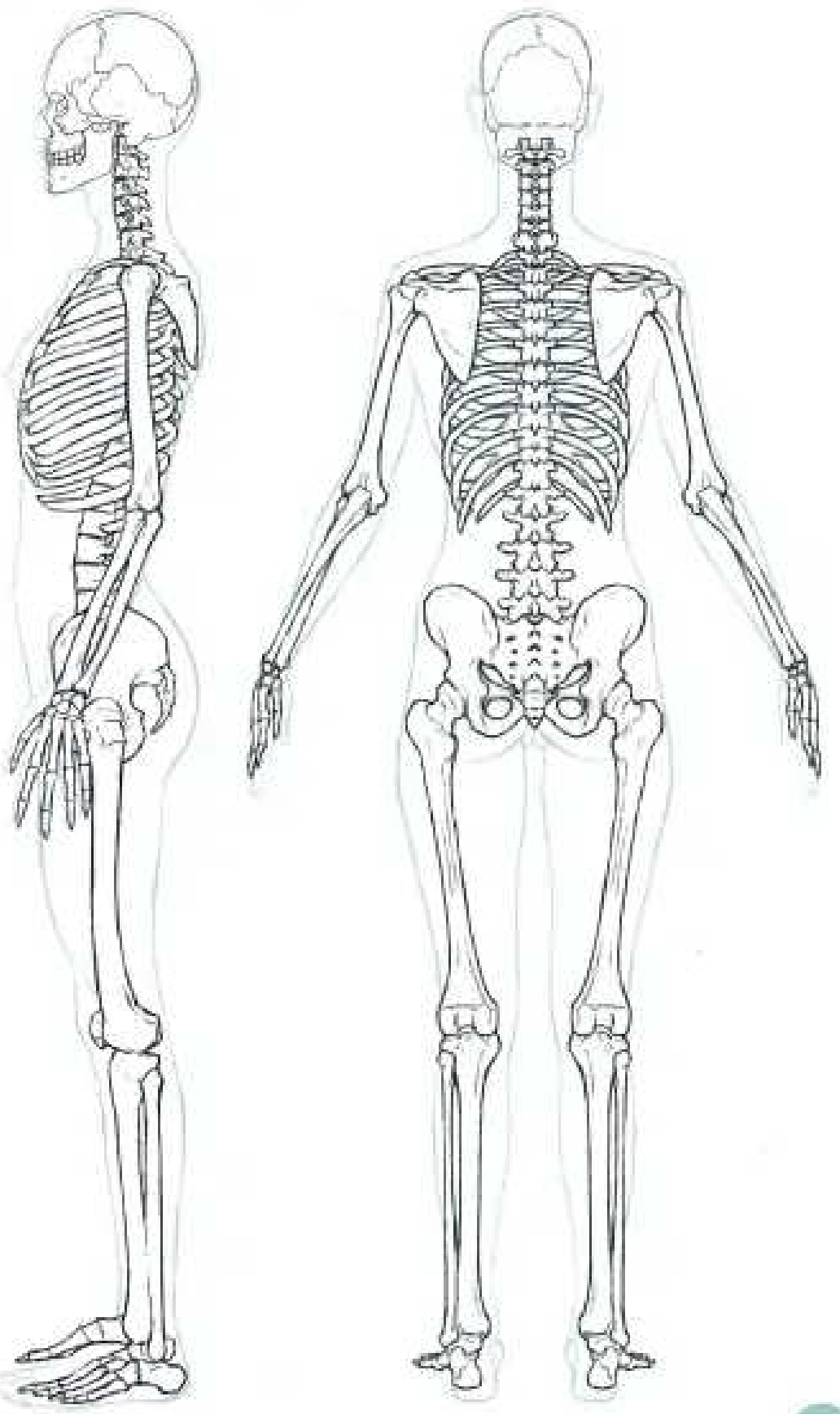
The skeleton is our body armor. The skull, for example, is like an organic helmet that protects the brain from injury or trauma. In the same way, the rib cage protects the vital organs in the torso. The spine is an intricate system of bones that contain and protect the spinal cord, the body's vital nerves. The pelvis or hip bone not only allows us to stand upright, but also contains and protects the lower intestines and the sexual organs.

The skeleton's articulated joints allow us to move our limbs freely. The arms articulate at the shoulder, elbow, and wrist. The legs articulate at the hips, knees, and ankles. At the ends of the limbs we have the feet, which give us a rigid yet articulate base for standing, walking, running, and jumping.

The small and intricate bones of the hand and fingers allow for an incredible range of motion. The bones of the hands are designed to allow for precise control of the fingers.



▲ Anterior view of the skeleton



Lateral and posterior views of the skeleton

fig.01b

> "The pelvis contains and protects the lower intestines and the sexual organs, and also has a ball and socket joint function for the lower limbs"

01: The full skeleton

The major sections of the skeleton are the skull, torso, upper limbs, and lower limbs (fig.01a). Starting with the upper body, the first and most important skeletal structure is the skull. The major bones of the skull are the cranium and the mandible (lower jaw). Going down from the skull and connecting to the rib cage and pelvis is the spinal column. The spine consists of 33 bones known as vertebrae.

In the torso we find the rib cage. The rib cage is a series of curved bones that surround and protect many vital organs. The rib cage is composed of 12 curved ribs, the sternum (breastbone) in the chest, and the clavicles at the base of the neck. In the back, the scapulae (shoulder blades) connect the ribs to the upper limbs (fig.01b).

The upper limbs are made up of three sections: the upper arm, lower arm, and hand. The upper arm bone is the humerus. The lower arm is composed of the radius and the ulna. The bottom of the forearm makes up the wrist and connects to the hand. The hand is made up of many small bones that form the palm and fingers.

At the base of the torso we see the pelvis is composed of three fused bones. The pelvis contains and protects the lower intestines and the sexual organs, and also has a ball and socket joint function for the lower limbs.

The lower limbs are also made up of three sections: upper leg, lower leg, and foot. The upper leg bone is called the femur. The lower femur connects to the lower leg and makes up the knee joint. The lower leg bones are the tibia and fibula. The feet are composed of small bones that make up the foot, heel, and toes.

PROTIP

Break it up into bite-size pieces

As you can see, I break down the major sections of the skeleton into smaller components: the skull, torso, upper limbs, and lower limbs. Because there are so many bones, grouping this way makes it easier to memorize and understand their function – you may find this useful as you find out more about human anatomy and discover the number of muscles there are to become familiar with!

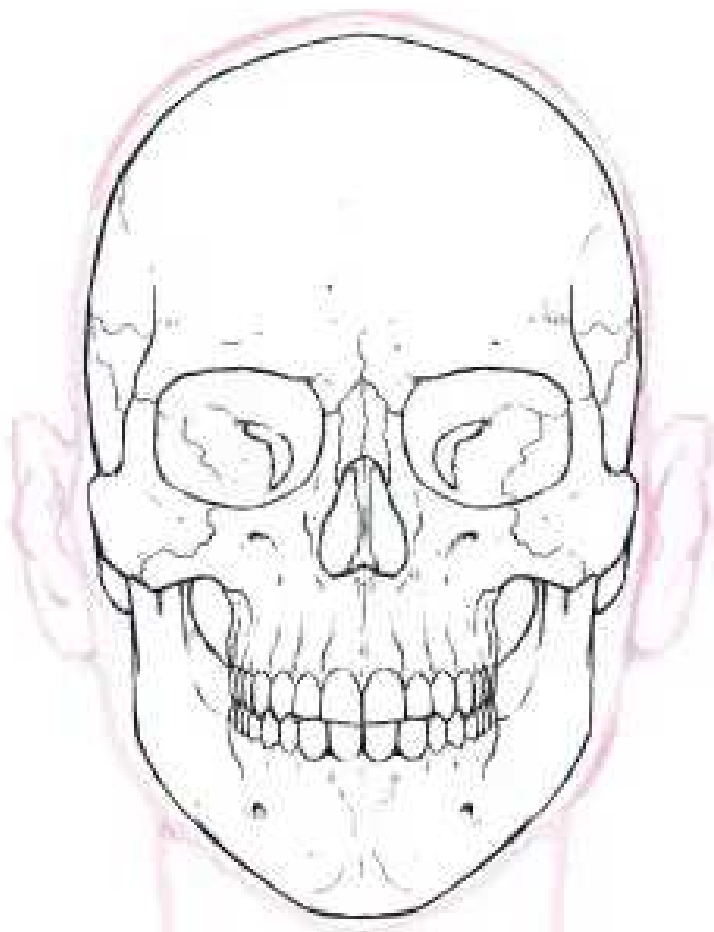
"The cranial section is a round, ball-like structure that contains and protects the brain and also acts an insertion point for the spinal column and nerves of the spinal cord"

02: The skull

We see that the skull has three major sections: the cranial section, frontal section (or the face), and jaw.

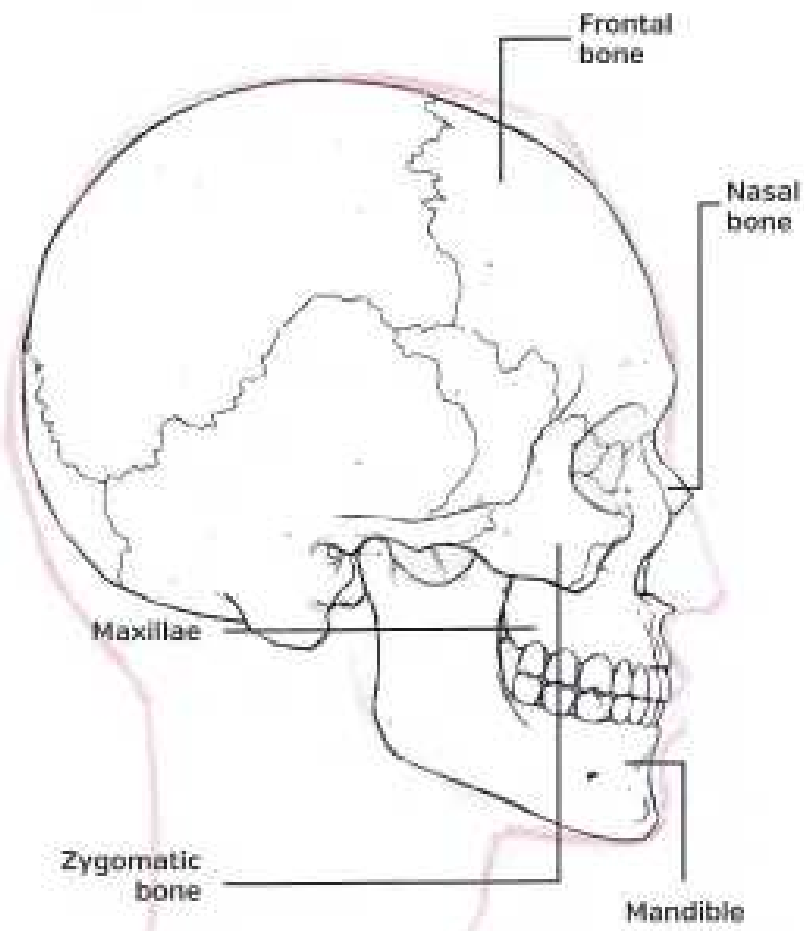
The cranial section is a round, ball-like structure that contains and protects the brain and also acts an insertion point for the spinal column and nerves of the spinal cord. Because the brain is so important, the bones of the skull, especially in the cranium, are extremely strong. The cranium is composed of several fused bones known as plates. Where they fuse is known as a suture (fig.02a, fig.02b, fig.02c).

At the front of the cranium is the frontal bone which leads down to the bones



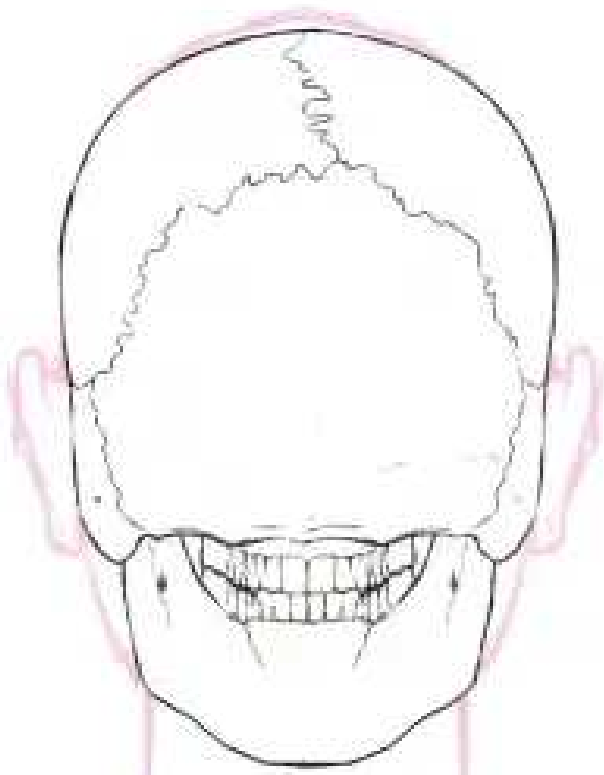
02a

Anterior view of the skull



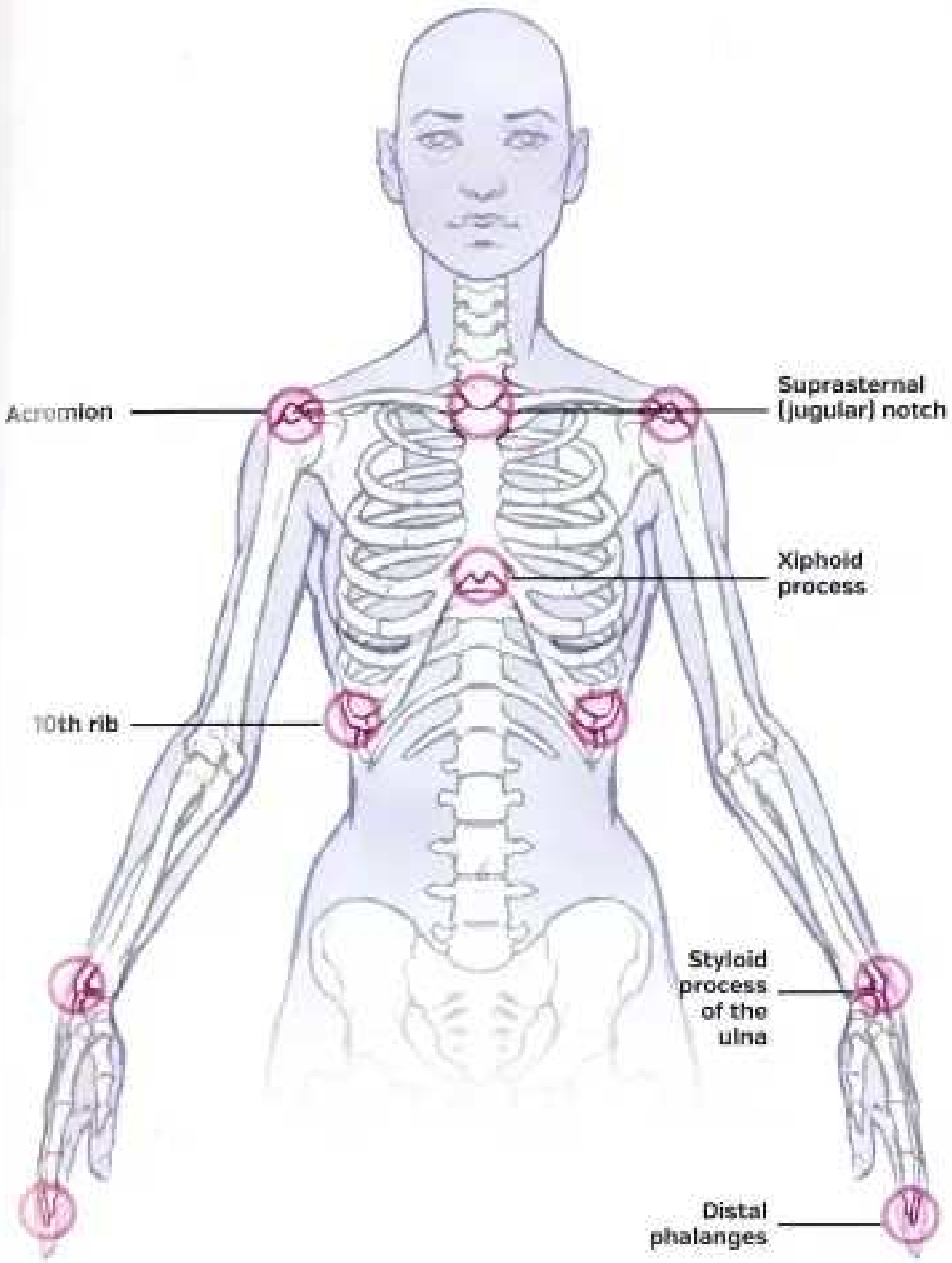
02b

Lateral view of the skull



02c

Posterior view of the skull



03.a

Upper body landmarks (anterior view)

of the face. Like the cranium, the facial bones are fused together in plates and sections like a jigsaw puzzle.

The eye sockets are composed of several fused plates that contain and protect the eyes and optic nerves. The inner section of the eye socket is the nasal bone, which connects to cartilage and makes up the nose. Beside the eye socket is the zygomatic bone, also known as the cheekbone.

Going down to the teeth, we have the maxillae bones (the upper jaw). There are 32 teeth in total, both upper and lower. The lower teeth insert into the mandible (the lower jaw). This powerful bone is hinged to allow the mouth to open and close. The mandible is a floating bone that is held to the skull by the muscles of the jaw.

03: Upper body landmarks

When observing the body, there are areas where the bones come close to the surface of the skin and create "bony landmarks". These landmarks help us identify and locate the bones when drawing or modeling the figure [fig.03a].

PROTIP

Anterior and posterior

As you become more familiar with human anatomy, you will most likely come across the terms "anterior" and "posterior".

Anterior refers the front of the body or organ, for example the tibialis anterior is located on the front of the tibia.

Posterior is the opposite of anterior and refers to the back of the body or organ. For example the tibialis posterior is located on the back of the tibia.

When looking at front of the upper body, starting at the neck and shoulders, we can see the clavicles. At the shoulders, the bones that stick out are the acromion, which are the bony protrusions of the scapulae.

In the center of the chest, the sternum is often visible. The bottom of the sternum is the xiphoid process, which can be seen when the body inhales. As for the ribs, many can be seen, but the ones to note are the bottom, 10th ribs and the connecting costal cartilage. The cartilage connects the ribs to the sternum and can be seen when the body inhales.

> "At the bottom on the triangular scapula we can see the inferior angle which resembles a blade or knife. This can easily be seen when the arm is extended or raised"

In the arms the most visible bones are the wrist and elbow [fig.03b]. The elbow is the head of the ulna, known as the olecranon. The wrist bones that protrude most are the head of the radius and the styloid process of the ulna. The terminal (or distal) phalanges are the last bones of the hand, forming the fingertips.

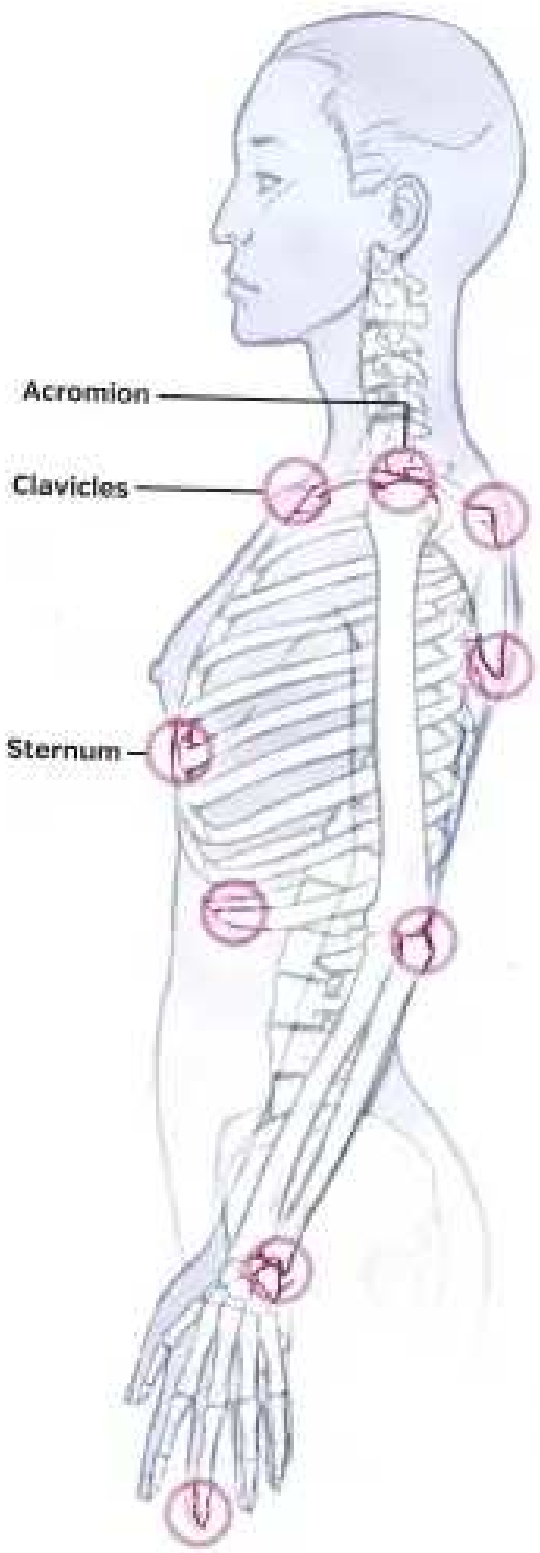
Looking at the figure from behind, we can see several bones in the upper body [fig.03c]. The bone that appears as a lump at the base of the neck is the 7th cervical vertebra (or C7). At the shoulders we can see two parts of the scapula. At the top near the shoulder, we see the spine of the scapula, which extends to create the socket for the shoulder joint. At the bottom on the triangular scapula we can see the inferior angle which resembles a blade or knife. This can easily be seen when the arm is extended or raised.

> "At the hip joint, the head of the femur, known as the greater trochanter, can be seen from the side. It is surrounded by the large muscles of the hips and thighs so it will often appear as a depression or dimple"

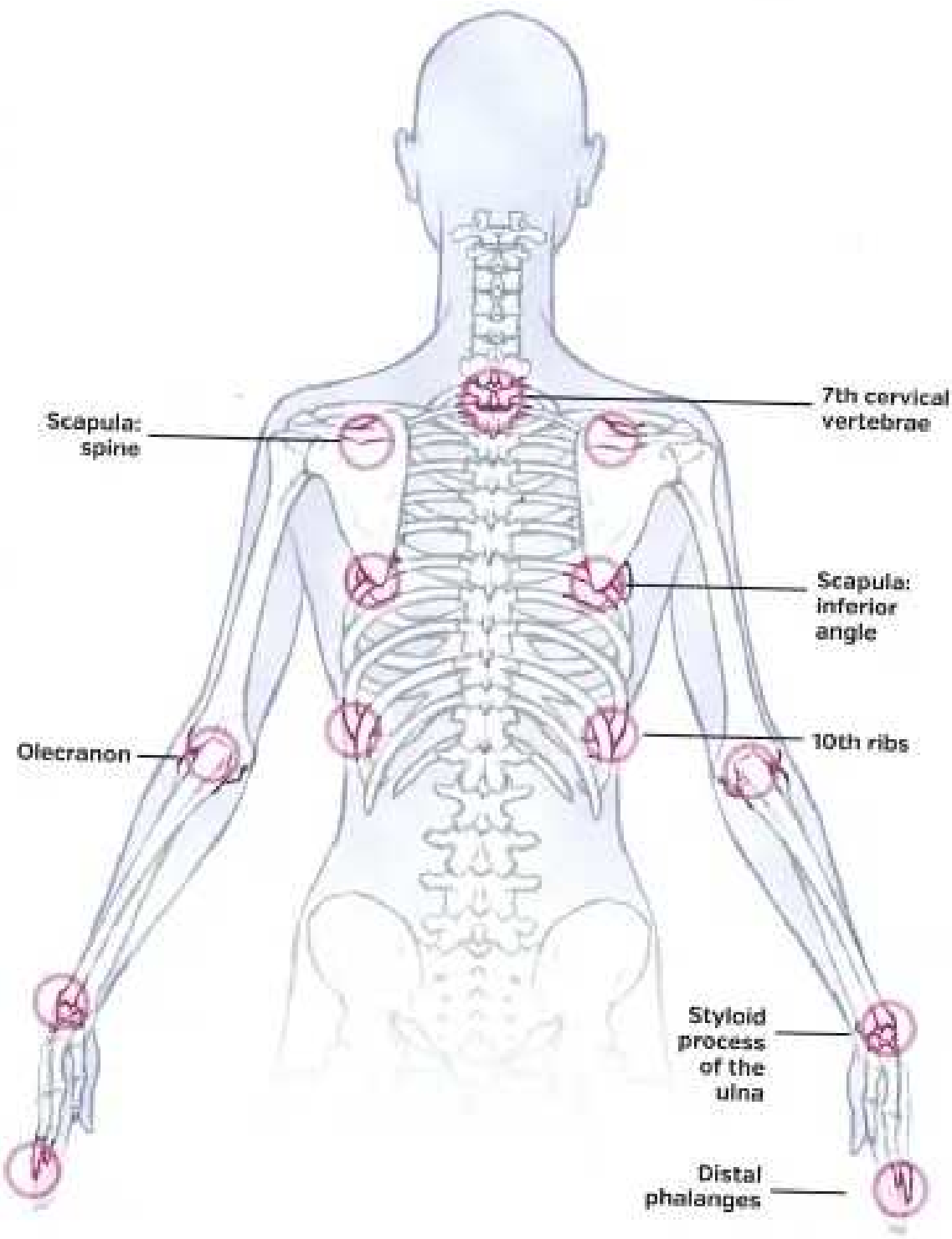
04: Lower body landmarks

When we observe the lower body, landmarks can be seen in the hips, knees, and ankle joints. Starting with the hips from the front [fig.04a] and side [fig.04b] views, the most obvious landmark is the iliac crest of the wings of the pelvis. It is visible at the sides of the hips, just below the navel, and is more visible on females. The iliac crest is a great way to mark the end of the abdomen and the beginning of the hips.

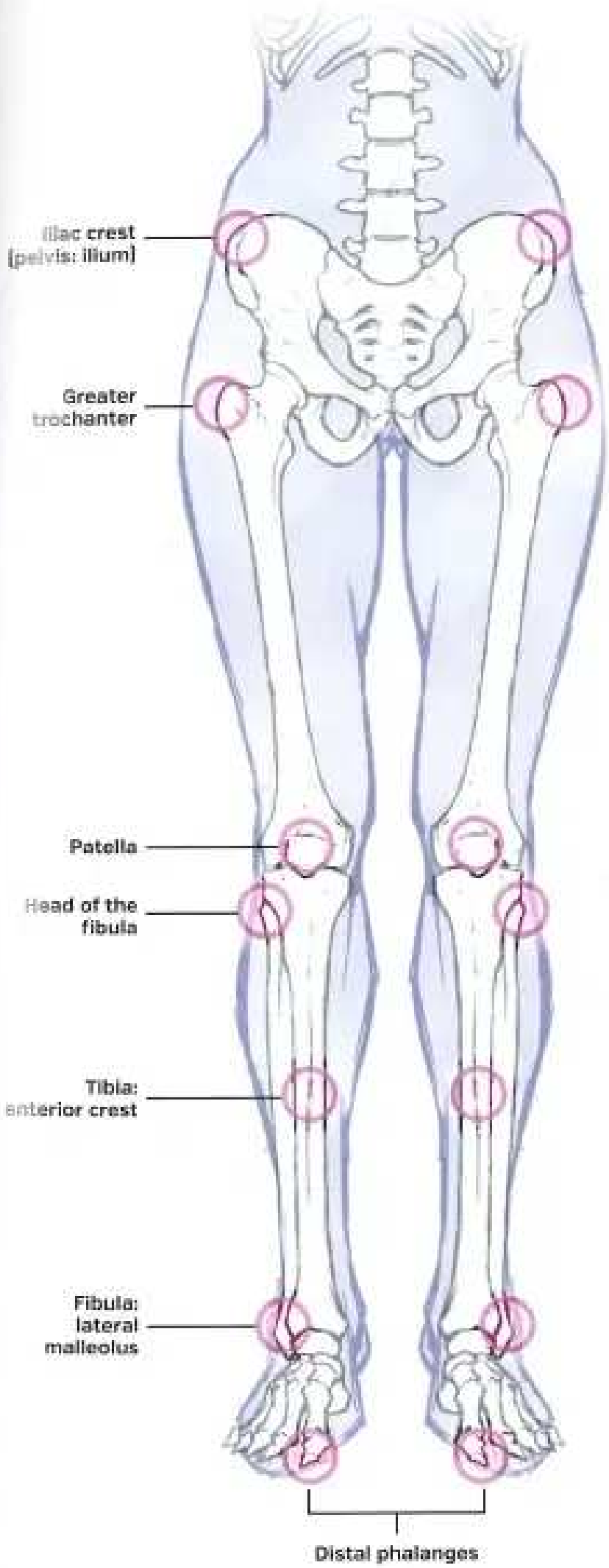
At the hip joint, the head of the femur, known as the greater trochanter, can be seen from the side. It is surrounded by the large muscles of



▲ Upper body landmarks - lateral view 03b



▲ Upper body landmarks - posterior view 03c



04a

Lower body landmarks (anterior view). The pelvis and many bones in the legs, ankles and feet come close to the surface of the skin, making them visible

04b

Lower body landmarks (lateral view)

the hips and thighs so it will often appear as a depression or dimple.

Moving down to the knee we are able to see the kneecap or patella. We can also observe the head and upper portion of the tibia from the front view, and the head of the fibula on the sides of the knee joint. The tibia almost flattens out as we move down to the feet. The sharp section of the shin is known as the anterior crest of the tibia [also referred to as the shin bone].

Moving down to the ankle and foot, we can observe the lateral malleolus that makes up the outer ankle bone. The inner ankle bone is the medial malleolus [fig.04c].

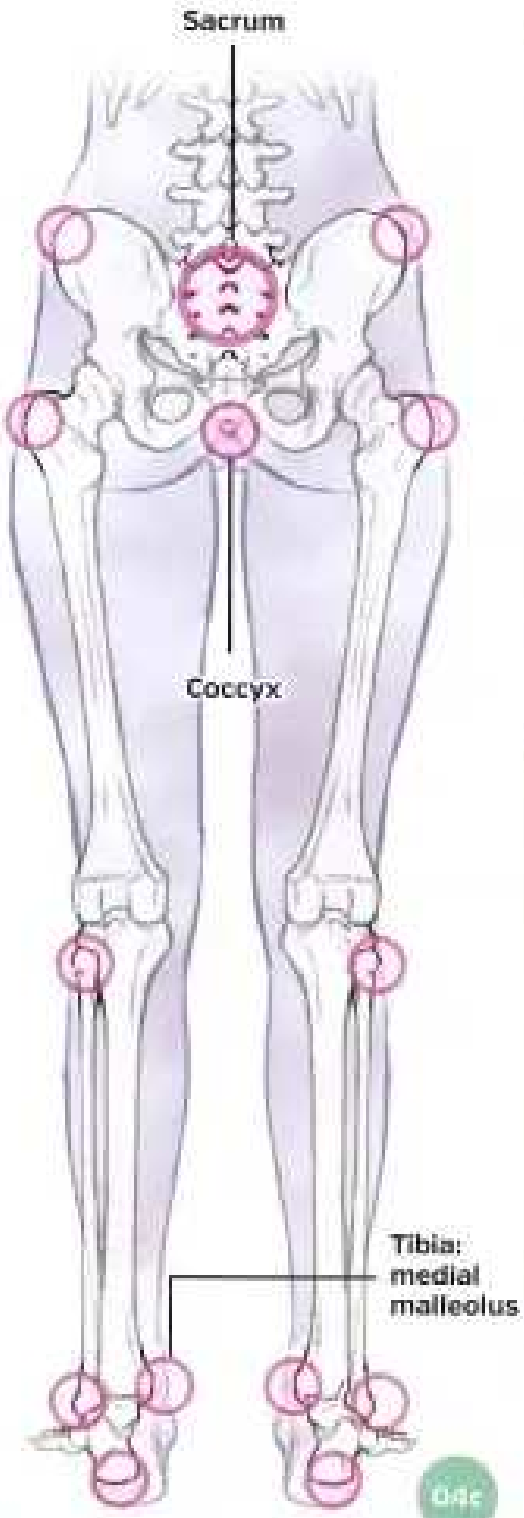
At the foot, we are able to see the bulge of the heel, which is the calcaneus. The tip of the big toe is the distal phalanx.

"Between the eye sockets we can see the protruding point of the nasal bone. This can often be seen as a bump on the bridge of the nose, where the nasal bone meets the cartilage of the nose"

From behind we can see the bone that connects the spine to the hips, which is known as the sacrum. The sacrum can often be seen as small depressions or dimples in the lower back. At the bottom of the sacrum we get the coccyx, or tail bone, which can easily be seen if the body is bending forwards.

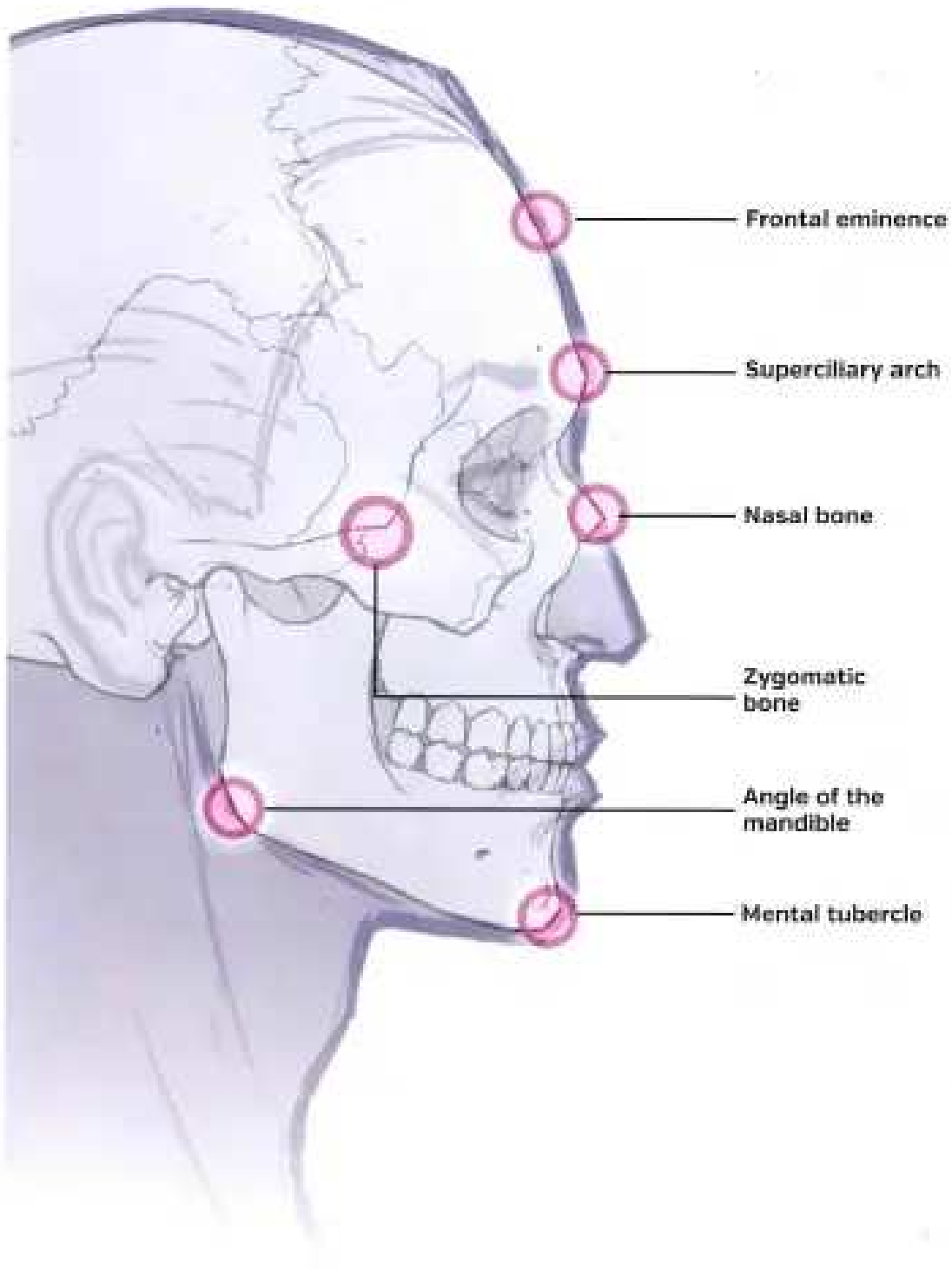
05: Facial landmarks

We'll now take a look at the landmarks of the face. Starting with the head, at the top of the face we can see the protrusion of the forehead. This bump is part of the frontal bone and is known as the frontal eminence



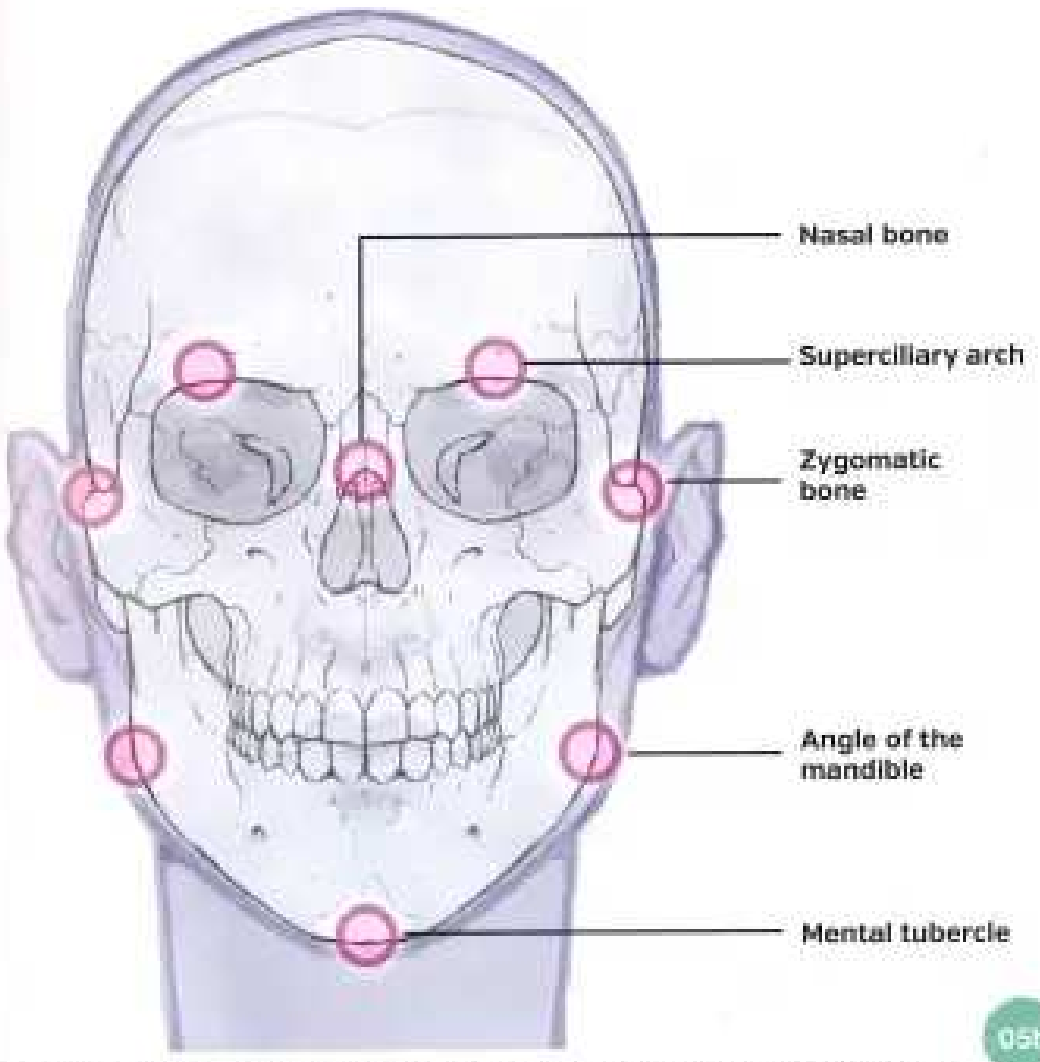
04c

▲ Lower body landmarks – posterior view



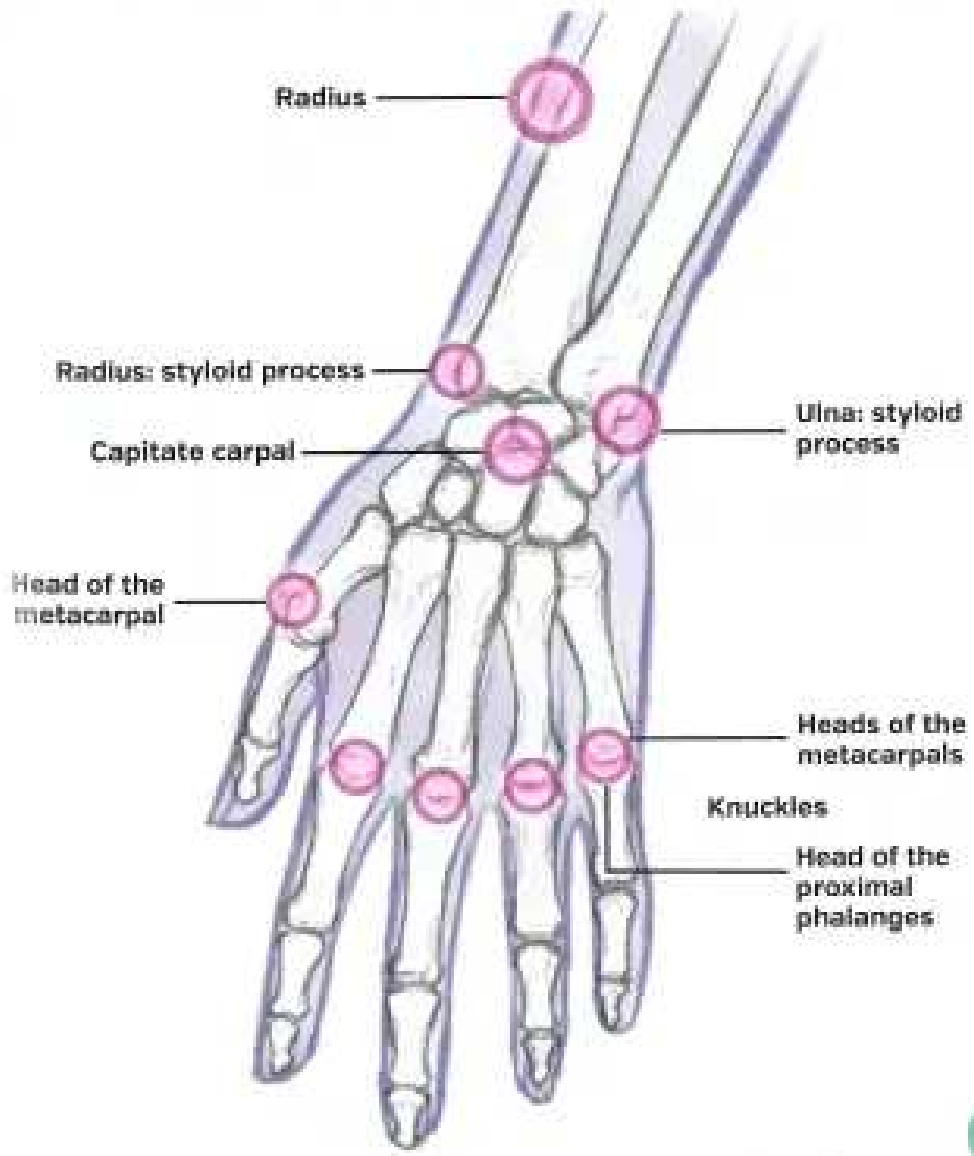
05a

▲ The major landmarks of the skull and face - lateral view



05b

▲ The major landmarks of the skull and face (anterior view). Many parts of the skull and jaw are easily seen on the face



06

▲ Dorsal view of the landmarks of the wrist and hand. Wrist bones can be easily seen. The large knuckles are a combination of bones in the palm and the fingers

[fig.05a]. Moving down to the eyes, we can see the top of the eye socket or the brow bone. This is another part of the frontal bone, also known as the supraorbital ridge or superciliary arches.

"The cheekbone is also known as the zygomatic bone. The zygomatic bone makes up part of the eye socket and extends back towards the ear, in an extension known as the zygomatic arch."

Between the eye sockets we can see the protruding point of the nasal bone [fig.05b]. This can often be seen as a bump on the bridge of the nose, where the nasal bone meets the cartilage of the nose.

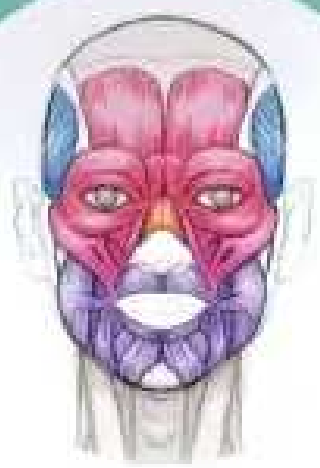
At the sides of the face, below the eye sockets, we can easily see the cheekbones. The cheekbone is also known as the zygomatic bone. The zygomatic bone makes up part of the eye socket and extends back towards the ear, in an extension known as the zygomatic arch.

The lower jaw or mandible has two clear landmarks. In the front we see the point that makes up the chin. This is known as the mental tubercle. At the back and sides, we see the pointy angle of the mandible. This makes up the back of the jaw bone and moves upward in almost a 90-degree right-angle towards the ear.

06: Hand landmarks

The other major landmarks to note are in the hands. In the hand and wrist, we see the head of the radius and the styloid process of the ulna. The ulnar styloid process appears as a bump on the outer part of the wrist.

Next is the capitate bone, which is the biggest carpal bone in the wrist. The long bones of the palm are known as the metacarpals. The large knuckles of the hand are joints made up of the metacarpals and the first bones of the fingers (the proximal phalanges).



Drawing an archetypal figure

2D female

Part 03 | Muscles

By Chris Legaspi

Concept artist and oil painter

The muscles of the body are the drivers and engine for movement. They provide the momentum to move bones, allowing them to move together or apart. They allow the body to move with powerful force and with delicate grace. The muscular system, along with the complementary tendons and ligaments, is like a near-perfect biological machine that is truly a marvelous display of engineering.

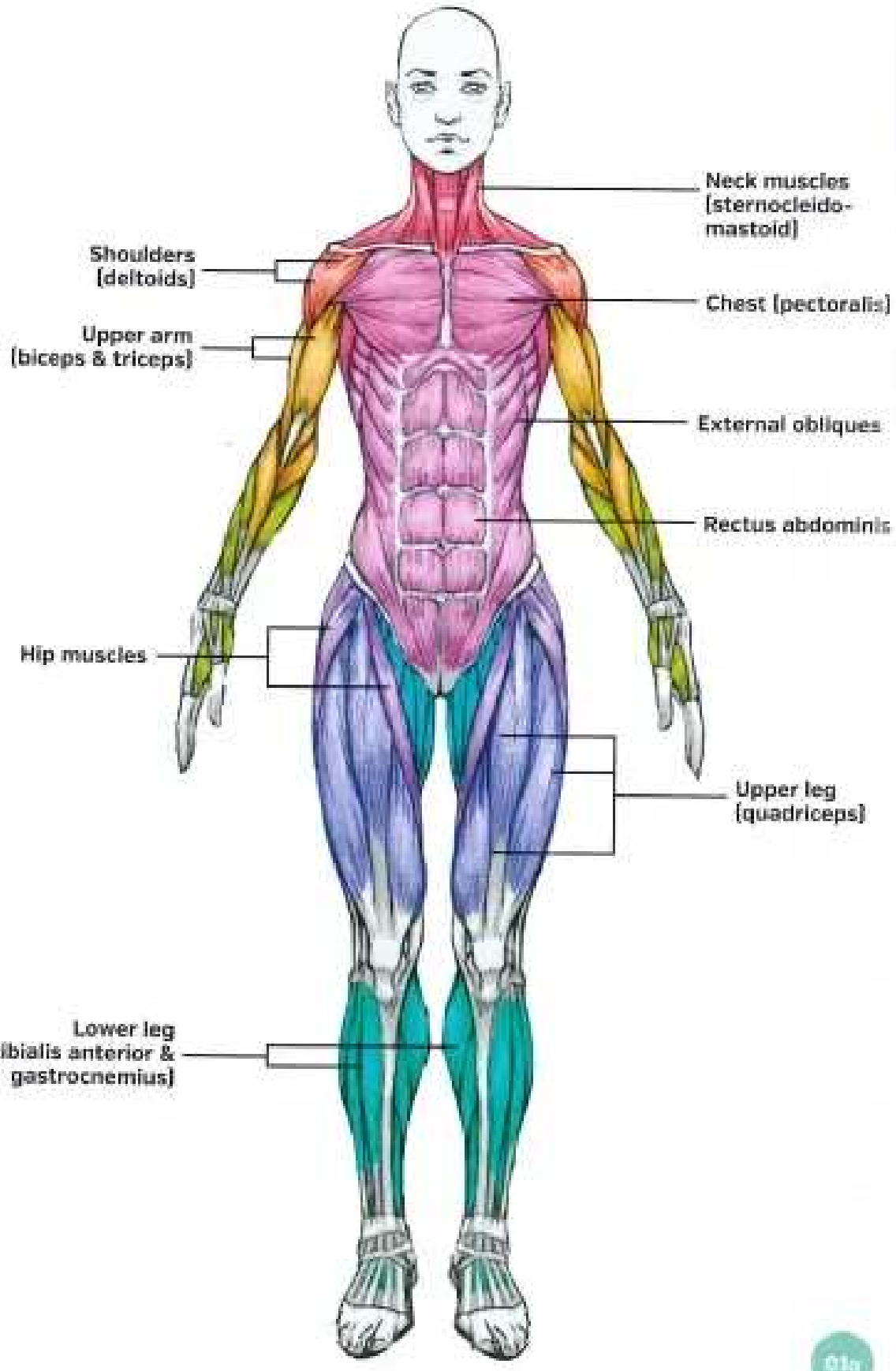
When observing the muscles, I like to organize them into two parts: the upper and lower body. The upper body is composed of the muscles that surround the rib cage, shoulder joints, arms, hands, and of course the neck, head, and face. The lower body contains the massive muscles of the hips, buttocks, lower abdomen, upper (thighs), and lower (calves) legs and feet.

"It is easier to divide the body into two sections because looking at the muscular system as a whole can be daunting"

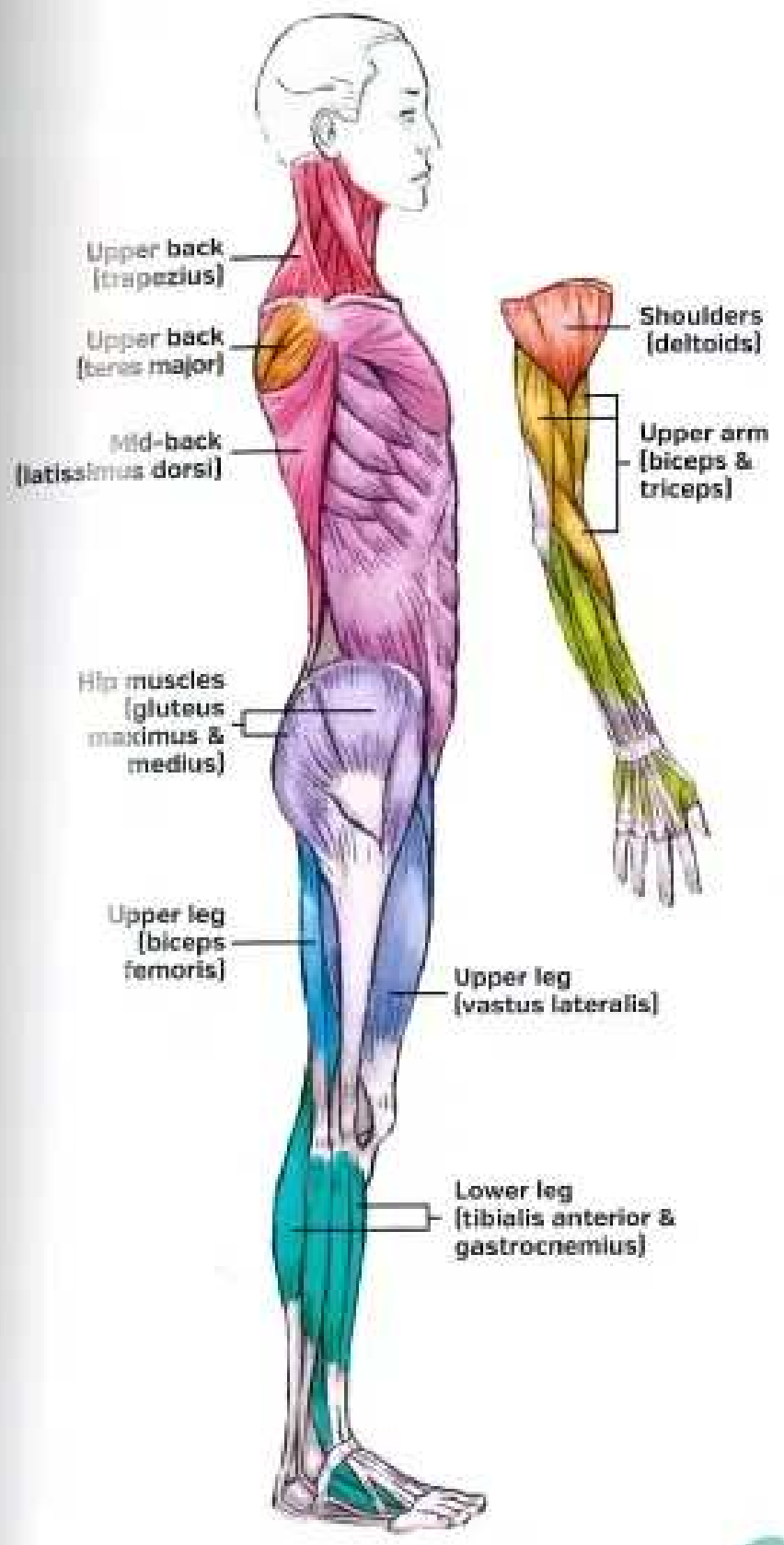
01: Muscle groups of the body

The muscular system is very complex at first sight; muscles perform various functions and they come in many shapes and sizes. It is easier to divide the body into two sections because looking at the muscular system as a whole can be daunting. It helps to simplify the over 600 individual muscles into fewer groups for studying, drawing, and sculpting.

The upper body can be further divided into three main groups, the torso muscle (or

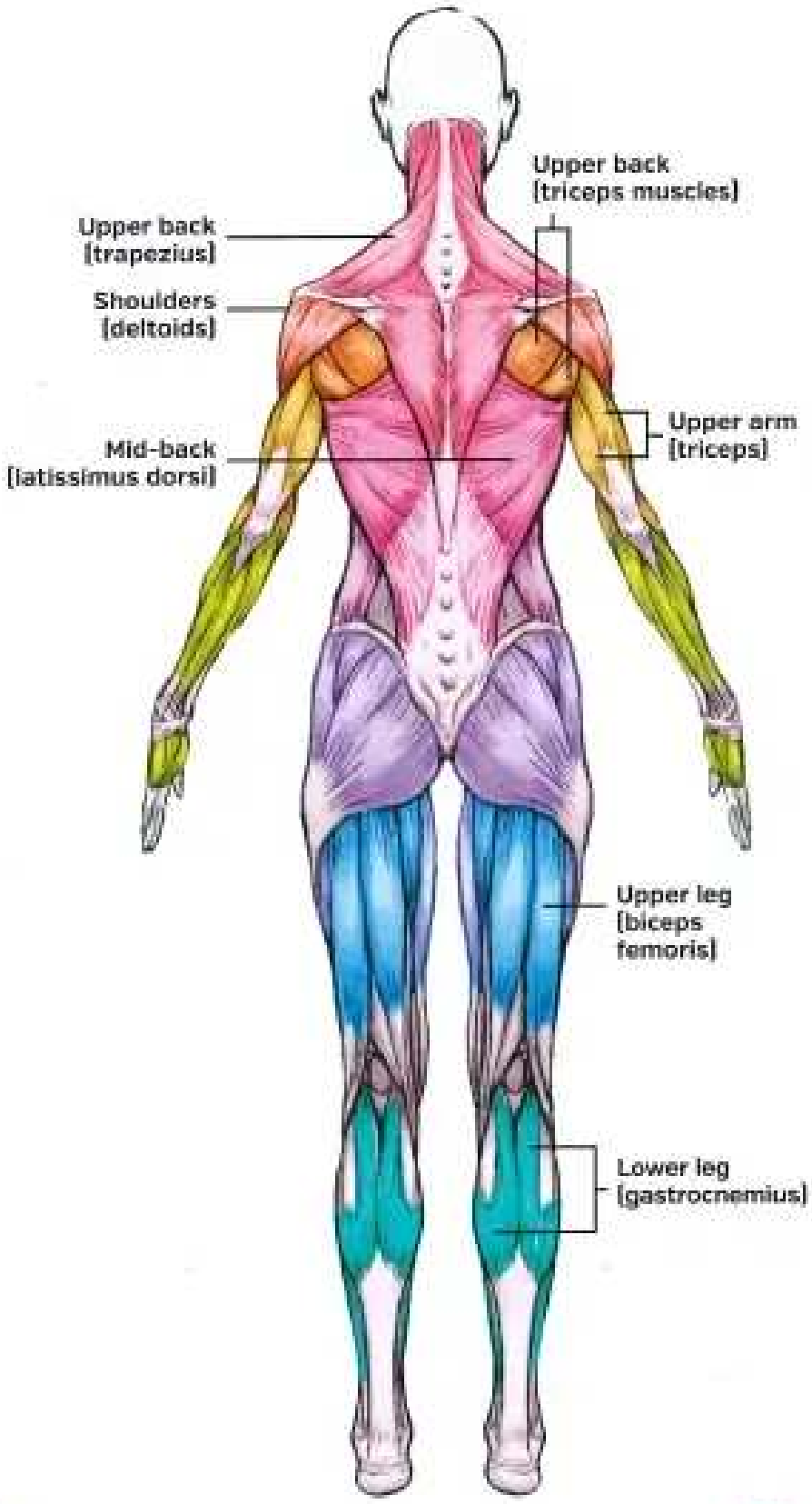


▲ The muscles in the torso are in large groups, with the abdominals and obliques making up most of the length of the torso


Upper back (trapezius)
Upper back (teres major)
Mid-back (latissimus dorsi)
Hip muscles (gluteus maximus & medius)
Upper leg (biceps femoris)
Shoulders (deltoids)
Upper arm (biceps & triceps)
Upper leg (vastus lateralis)
Lower leg (tibialis anterior & gastrocnemius)

01b

The oblique muscles that attach and surround the rib cage can be easily seen from the side



01c

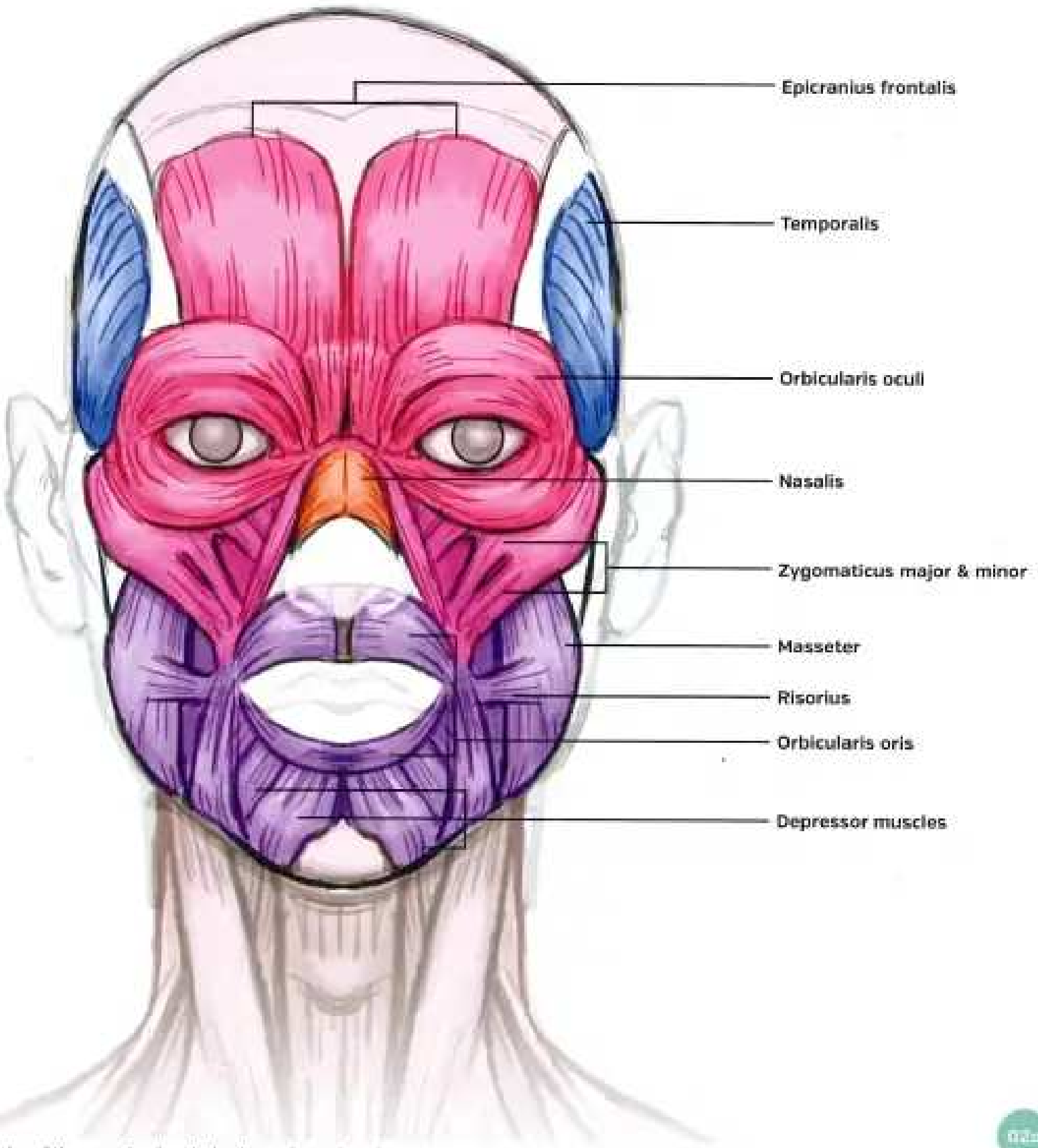
The trapezius and the latissimus muscles make up most of the mass of the back muscles

trunk), arms, and hands. The lower body has the muscles of the hips, legs, and feet.

In the upper body the largest mass of muscles is in the torso. From the front, the abdominals, obliques, and pectorals make up most of the surface area (fig.01a). Above the pectorals, the neck muscles connect the shoulders to the head. The muscles of the arm vary in size and complexity as they transition from shoulder to forearm and eventually into the hand and fingers. The massive trapezius and latissimus dorsi make up the majority of the back.

The lower body has the powerful hip and leg muscles. The gluteals which can be seen from the side (fig.01b) and rear (fig.01c) views are the largest muscles in the body. The upper legs (or thighs) are composed of many large and powerful muscles. From the front, the powerful quadriceps can be easily seen along with the adductor muscles that move legs inward toward the groin. From the side and rear views, the leg biceps that contract to move the foot towards the hips and buttocks can be easily seen.

The many muscles of the lower leg work like the muscles of the forearm and allow for motion of the foot and ankle.



▲ The muscles of the eyes, forehead, cheeks, and mouth make up most of the surface area of the facial muscles

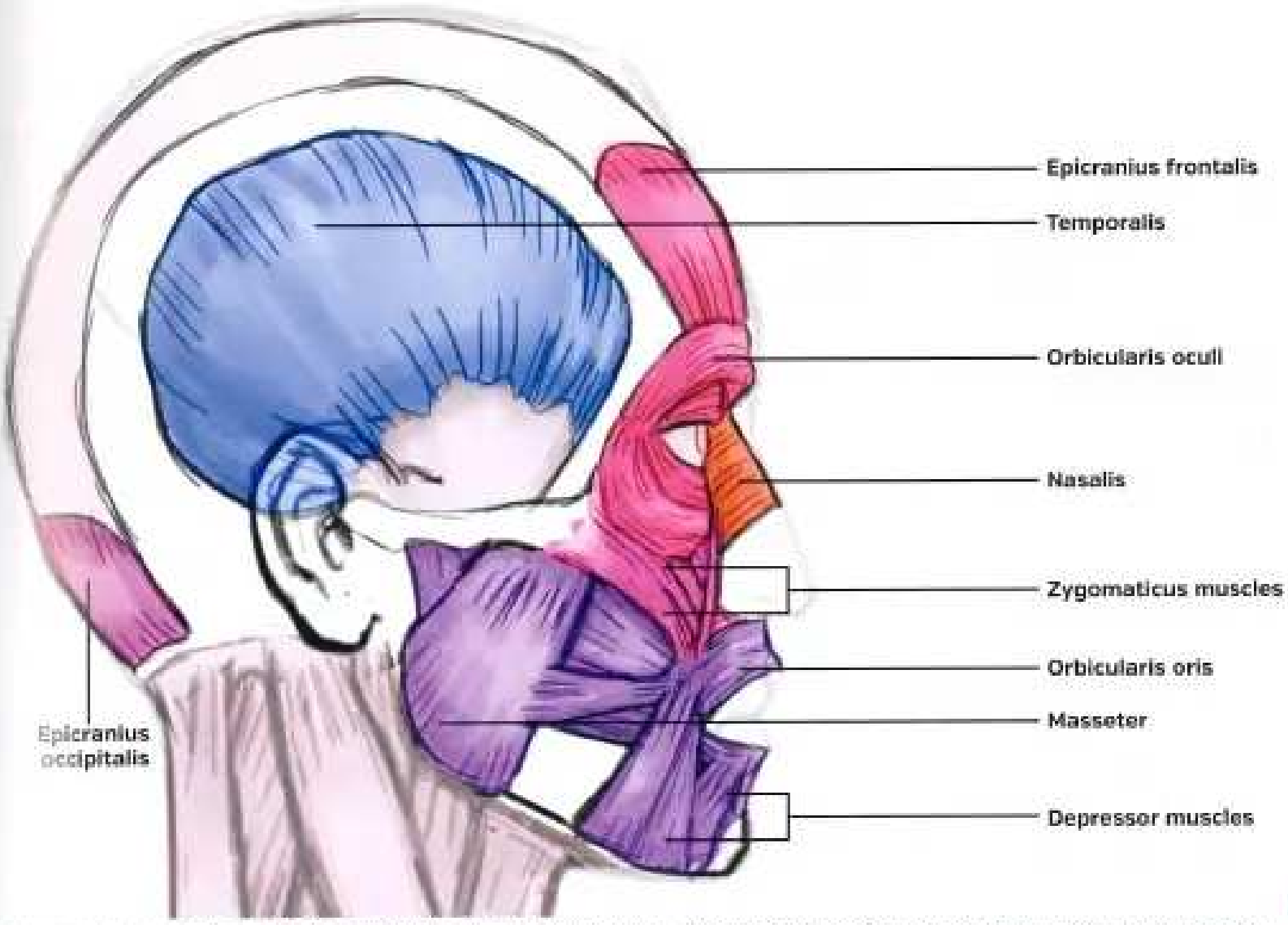
"They face can twist, distort, and contract in infinite ways and each combination of contraction can express a multitude of emotions"

02: Muscles of the head and face

There are over 40 muscles in the head and face. These muscles allow for very complex movement and expressions that are vital to life. Movements such as moving the eyes, nose, and mouth are critical for survival. The other function of the facial muscles is to express emotion. They face can twist, distort, and contract in infinite ways and each combination of contraction can express a multitude of emotions.

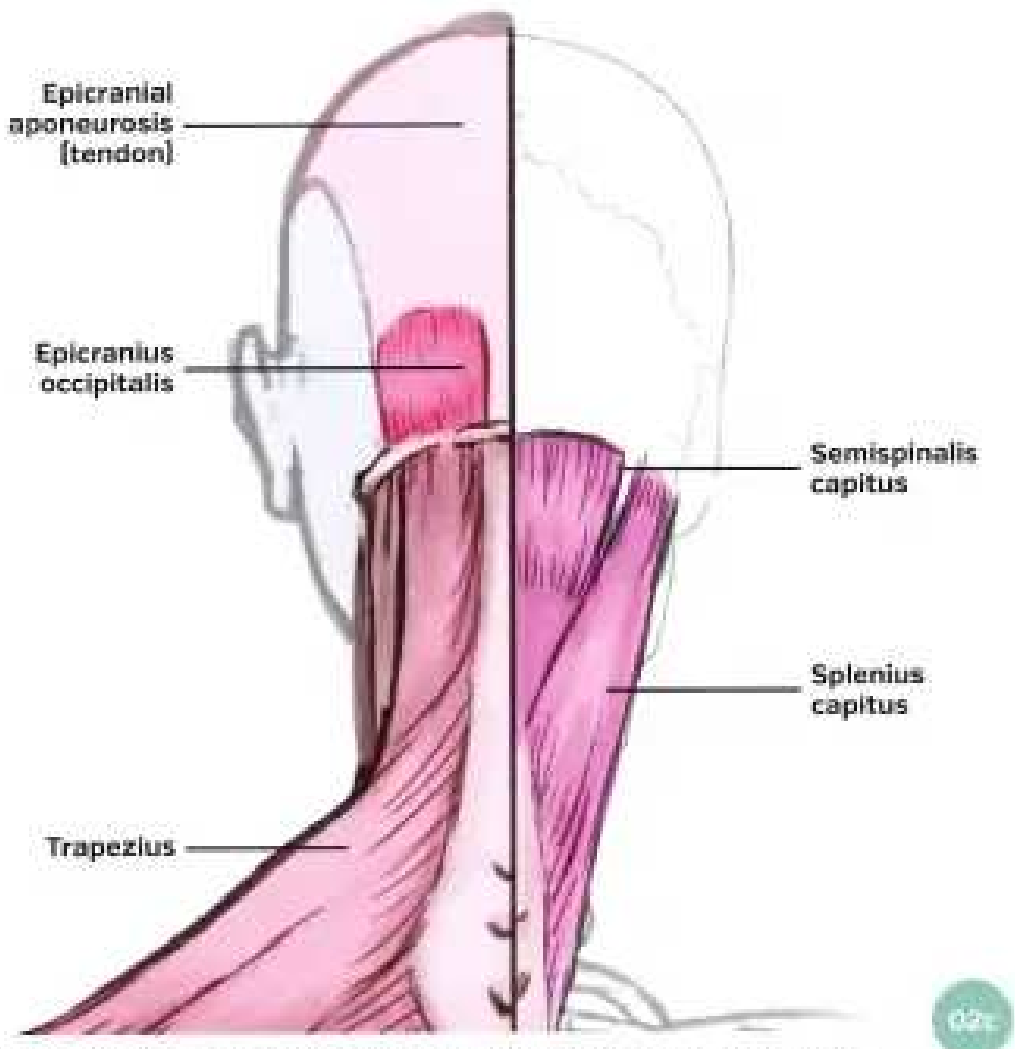
To help me simplify the complexity of the facial muscles, I once again tend to organize them into different groups. The main groups I use this time are: the muscles surrounding the eyes and forehead; the cheeks and nose; the mouth and jaw; and finally the upper neck as viewed from the back.

The main muscles surrounding the eyes are called the orbicularis oculi [Fig.02a]. They allow the eyelids to move and also protect the eye. The frontal belly of the epicranius muscle in the forehead moves the eye brows.



02b

A The massive temporalis muscle along with the powerful masseter muscle and the fine muscles of the mouth are easily seen from the side



02c

A The small epicranius muscle can be seen in a rear view while the massive trapezius muscle can be seen attaching to the back of the skull

The cheek muscles, such as the zygomaticus muscles, allow for expression by helping to move the corners of the mouth. At the nasal bone, the nasalis muscle helps with breathing by expanding the nostrils.

Moving the mouth and jaw requires coordination of many muscles. The mouth and lips are surrounded by the orbicularis oris which allows for a wide range of movement. The massive masseter muscle, which can be easily seen from the side, helps to move the jaw bone [fig.02b]. This powerful muscle is vital for opening the mouth and especially for chewing of food.

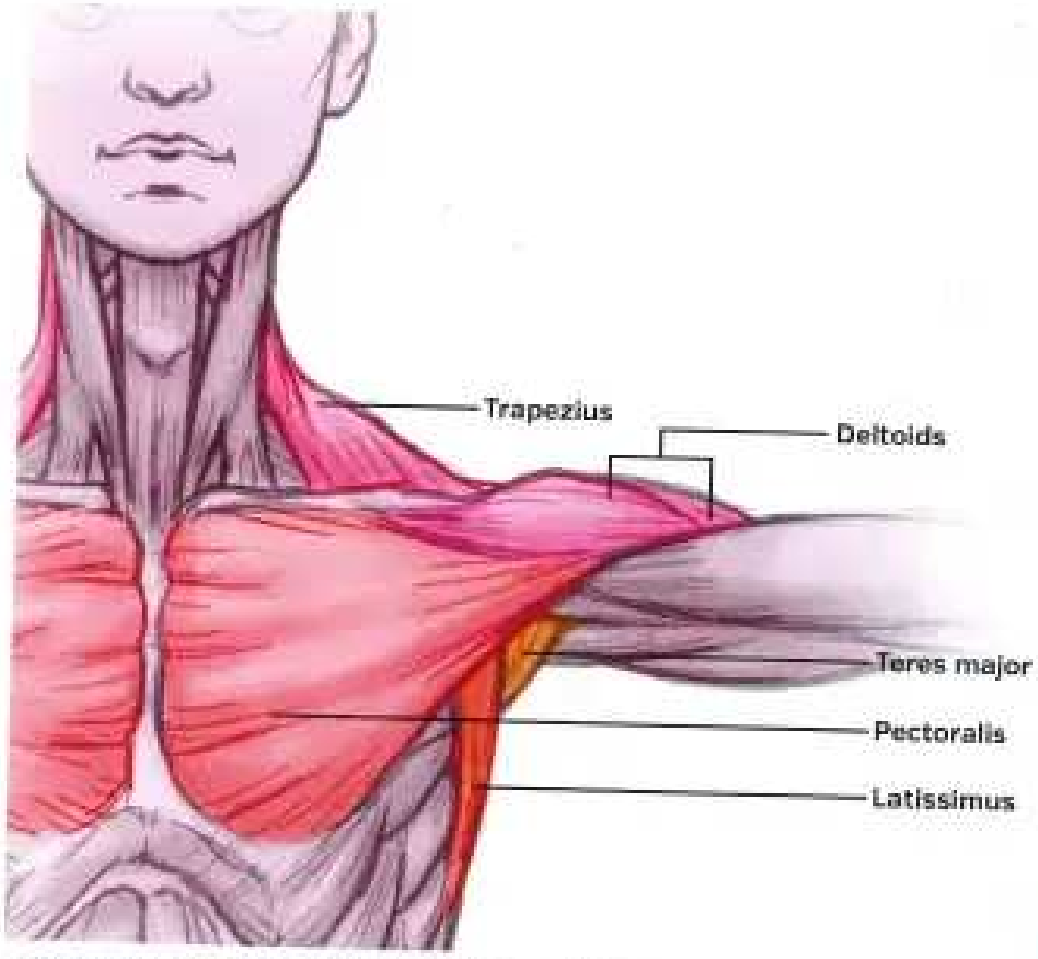
The massive temporalis muscle takes up a majority of the surface area of the side of the head. It originates at the side of the skull and attaches to the jaw bone. This muscle is responsible for raising the jaw (closing the mouth). From behind, the rear belly of the epicranius can be seen, along the with the upper neck muscles that attach to the back of the skull [fig.02c].

"The deltoids are a group of three distinct sets of muscle fibers which are the main drivers of the joint"

03: Muscles of the shoulder joint

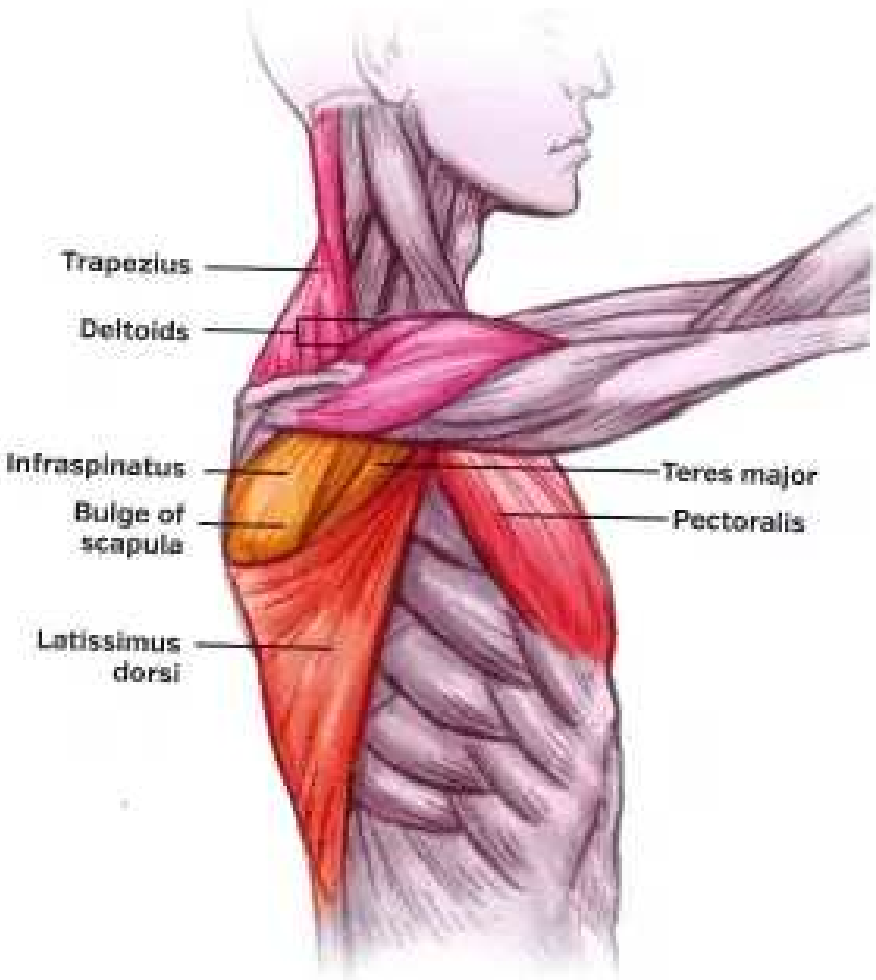
The shoulder joint is one of the most important joints in the body. To help me study the shoulder joint, I like to first think of its major function and then look at the muscles involved.

The joint itself works like a ball and socket, capable of moving the arm in a 360-degree range of motion. From the front, we can see the major muscles involved (fig.03a). First, the deltoids are a group of three distinct sets of muscle fibers which are the main drivers of the joint. Because of this they are often called the "shoulder muscles". The next muscle involved in moving the arm up is the trapezius.



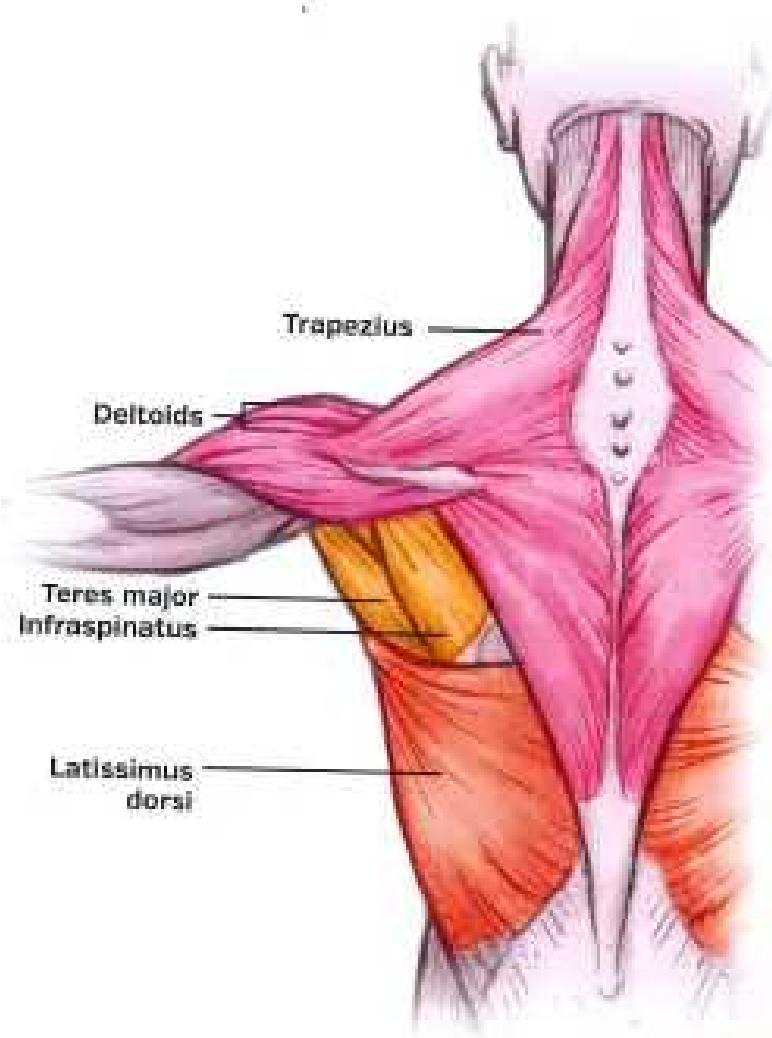
03a

▲ The front head of the deltoid muscles along with other complementary muscles like the pectoralis and trapezius make up the shoulder (anterior view)



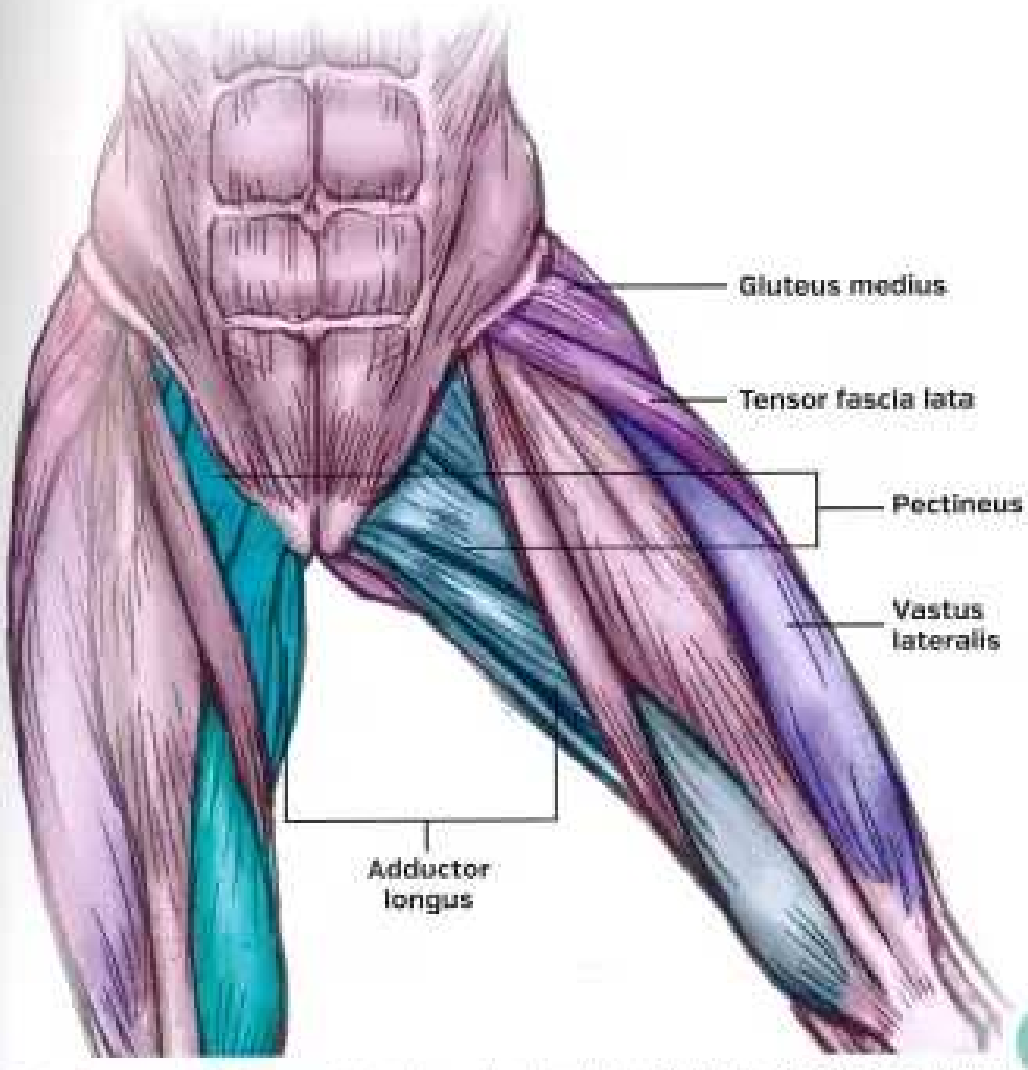
03b

▲ Raising the arm contracts the lateral head of the deltoids and trapezius, revealing the complementary muscles of the upper back



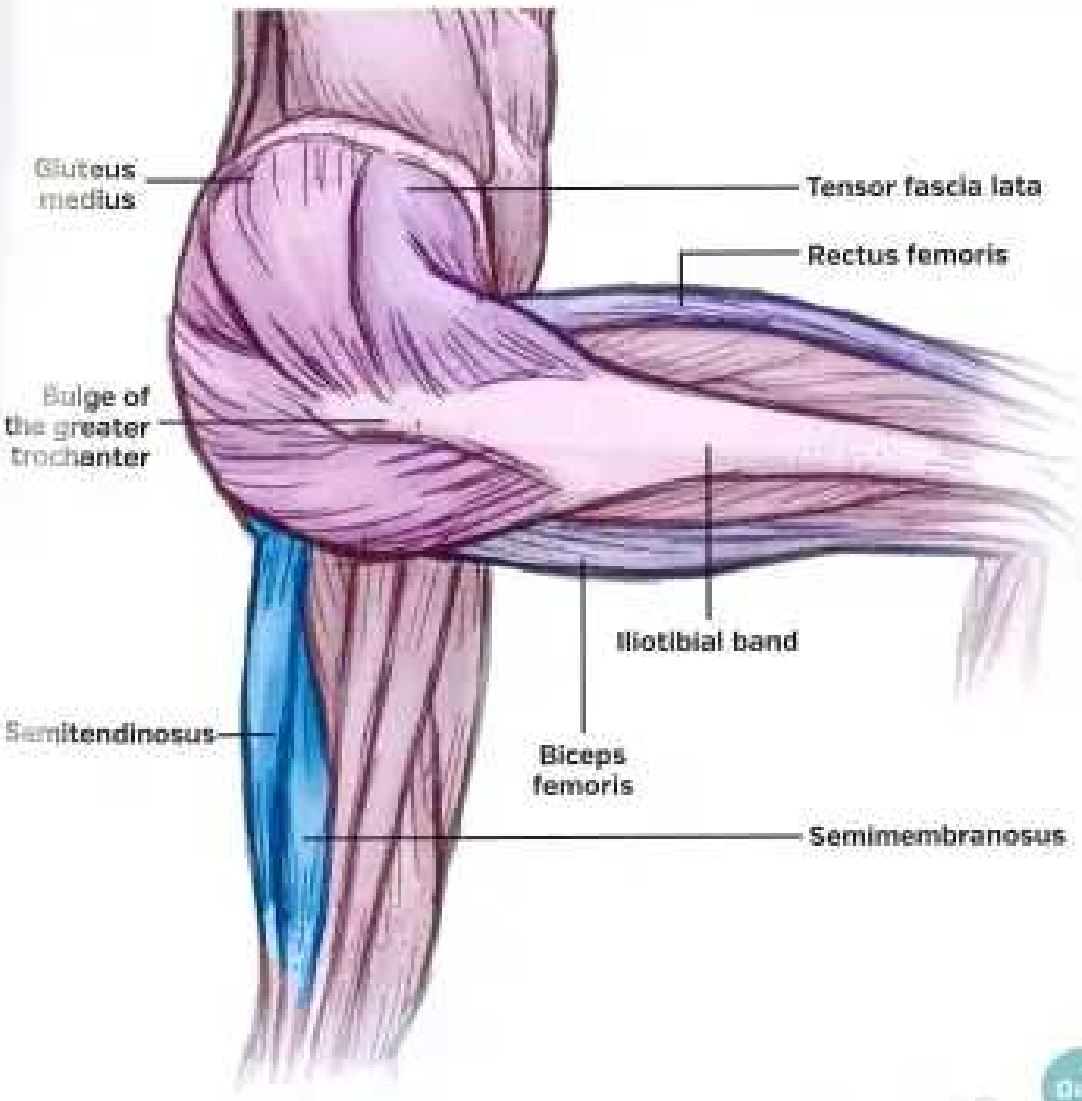
03c

▲ The massive trapezius and latissimus muscles surround the muscles that attach to the face of the scapula



04a

A The gluteus medius, tensor fascia lata, and vastus lateralis help to raise the leg outward, away from the body, while the adductor muscles bring the leg back.



04b

A The tensor fascia lata and rectus femoris help raise the leg up while the gluteals and hamstring muscles bring the leg back down

To move the arm towards the center of the body, the massive pectoral or "chest muscles" become involved. To move the arm down, the smaller teres major muscles and a portion of the latissimus muscle can be seen in the armpit.

"The large infraspinatus muscle, which occupies most of the space on the scapula itself, becomes visible. This powerful muscle helps to stabilize the shoulder and bring the arm down or back along with the latissimus muscle"

From a side view, we can better see the large belly of the deltoids contracting as the arm is raised [fig.03b]. The trapezius is also affected because it is attached to the spine of the scapula, which is the bony ridge that makes up part of the shoulder joint. The bulge of the blade of the scapula can be seen through the teres major and infraspinatus muscles. The large and flat latissimus muscle helps to bring the arm back to the body.

From behind, we can see the large trapezius and how it attaches to the scapula [fig.03c]. The large infraspinatus muscle, which occupies most of the space on the scapula itself, becomes visible. This powerful muscle helps to stabilize the shoulder and bring the arm down or back along with the latissimus muscle. This muscle can be easily felt contracting when doing a pull-up or chin-up motion in the arms.

04: Muscles of the hip joint

The hip joint is one of the most powerful joints in the body because it has to move the massive bones and muscles of the legs. The hips are composed of the largest and longest bones in the body, which are the pelvis and femur (upper leg bone). To move the legs requires coordination of many large and powerful muscles.

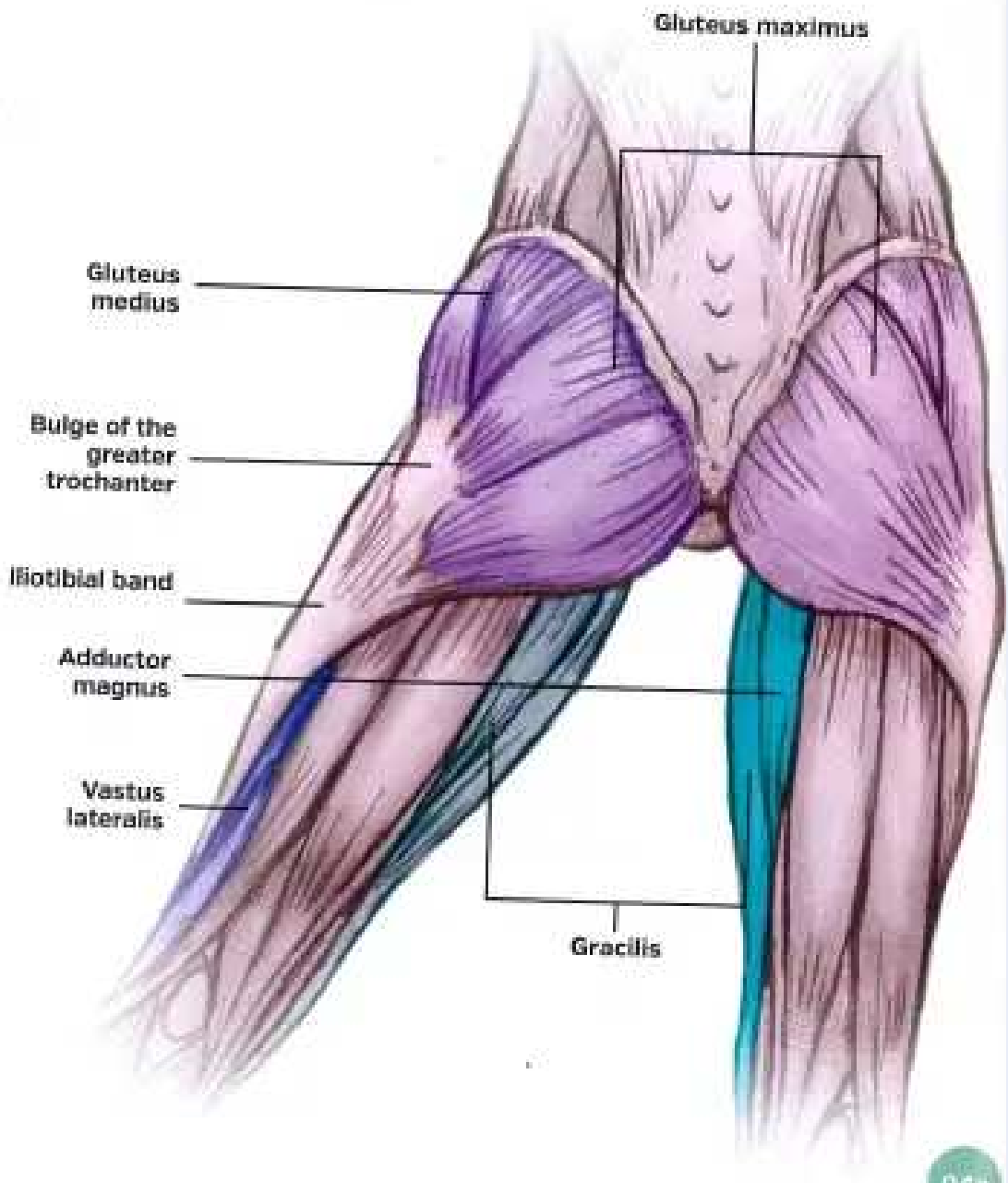
Like the shoulders, the hips are a ball and socket joint and allow the legs to move in a 360-degree range of motion.

Drawing an archetypal figure

From the front, the muscles of the outer hip, such as the gluteus medius and tensor fascia lata, help to raise the leg outward, while the vastus lateralis helps stabilize and also straighten the lower leg [fig.04a]. The many muscles of the inner thigh are to help "adduct" the leg or bring it back towards the midline. The largest of these muscles is the adductor longus.

From the side, the leg is raised by the tensor fascia lata along with the rectus femoris [fig.04b]. To return the leg the large gluteus medius is the primary muscle. The muscles in the back of the leg, such as the semitendinosus and semimembranosus, help to straighten the leg. The bulge of the great trochanter can be also be seen from a side view.

From behind, the gluteus medius can be seen contracting when the leg is raised [fig.04c]. To stabilize the leg, the iliotibial band can be seen. This long tendon originates at the hip at the tensor fascia lata muscle and extends the entire length of the upper leg. It attaches to the head of the tibia bone in the lower leg. To return the leg to the center, the adductor muscles can be seen contracting, especially the adductor magnus and gracilis, which become visible when seen from behind.



04a

▲ The gluteus medius and vastus lateralis move the leg away from the body. Adductor muscles like the adductor magnus help bring the leg back

05: Muscles of the hand

One of the interesting and complex parts of the body is the hand. It is capable of intricate, delicate, and precise motion. The wrist, hand, palm, and fingers contain an intricate network of small muscles, veins, and tendons.

When observing and studying the hand, I group the muscles and tendons into the forearm and wrist, hand, and then the palm. The fingers are also important, but there are no muscles in the fingers themselves; instead they are composed of bone and tendons.

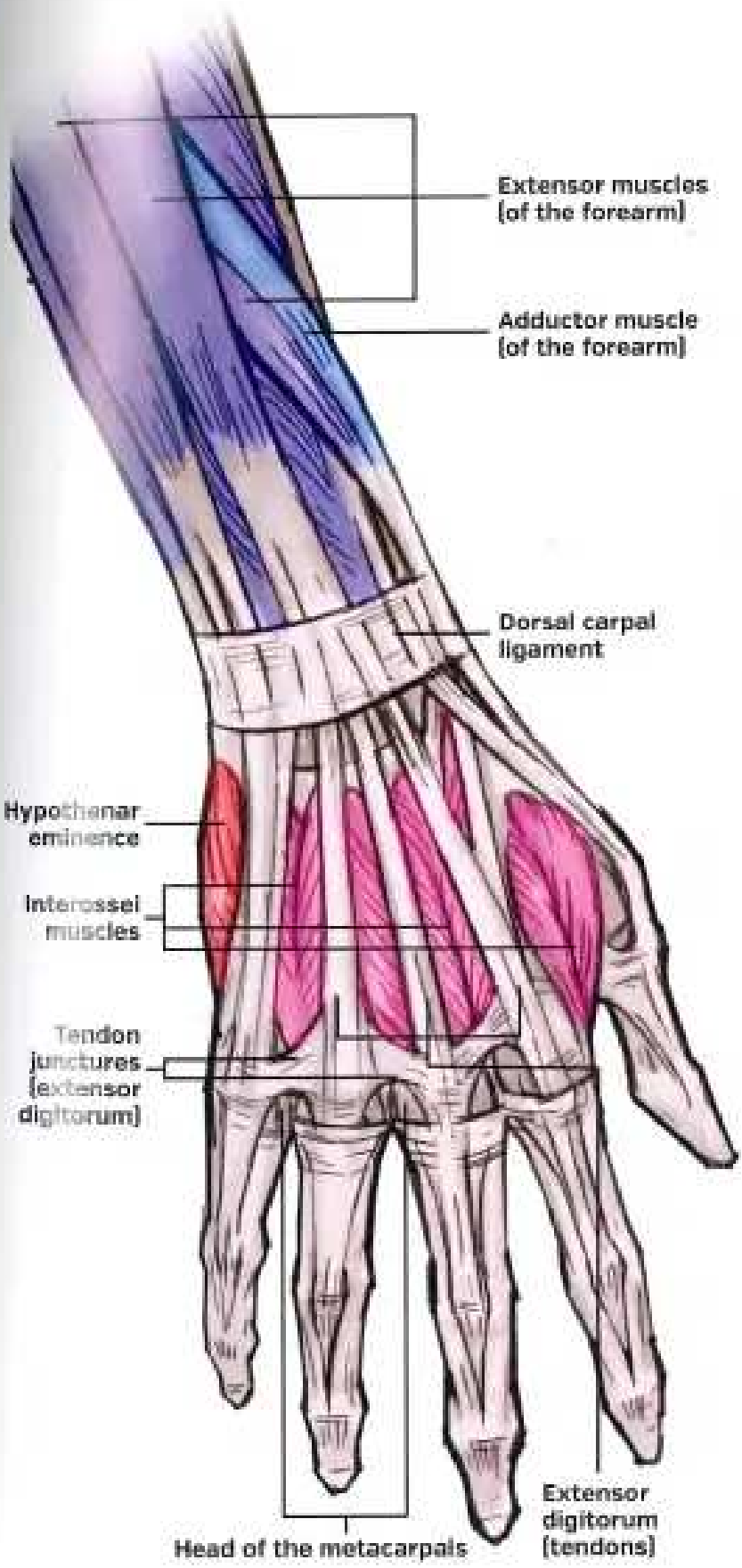
Starting in dorsal view at the forearm, the first set of muscles that can be seen are the extensor muscles [fig.05a]. These muscles extend or raise the hand and fingers toward the wrist and forearm. The muscles on the hand itself are known as the interossei muscles. They are located between the metacarpal bones of the fingers. Their function is to adduct the fingers or bring them towards the middle finger. The large tendons that can be seen are known as the extensor digitorum which, along with the extensor muscles, extend the fingers up.

In palmar view (palm up), the muscles of the forearm are known as the flexor muscles [fig.05b]. These muscles flex the hand and wrist to bring the hand and fingers toward the forearm. The muscles in the center of the palm are the lumbrical muscles which flex the fingers. At the thumb, the large brevis muscles can be seen, which help to move the thumb. When moving the little finger the abductor digiti minimi muscle can be observed.

From a lateral (or side) view, we can see the anatomy of the thumb. Starting at the wrist, the extensor muscles and the large extensor tendons flow into the thumb. The wrist is covered by the carpal ligament. When moving the thumb, the brevis muscles can be seen, along with the large interossei muscles in the palm.

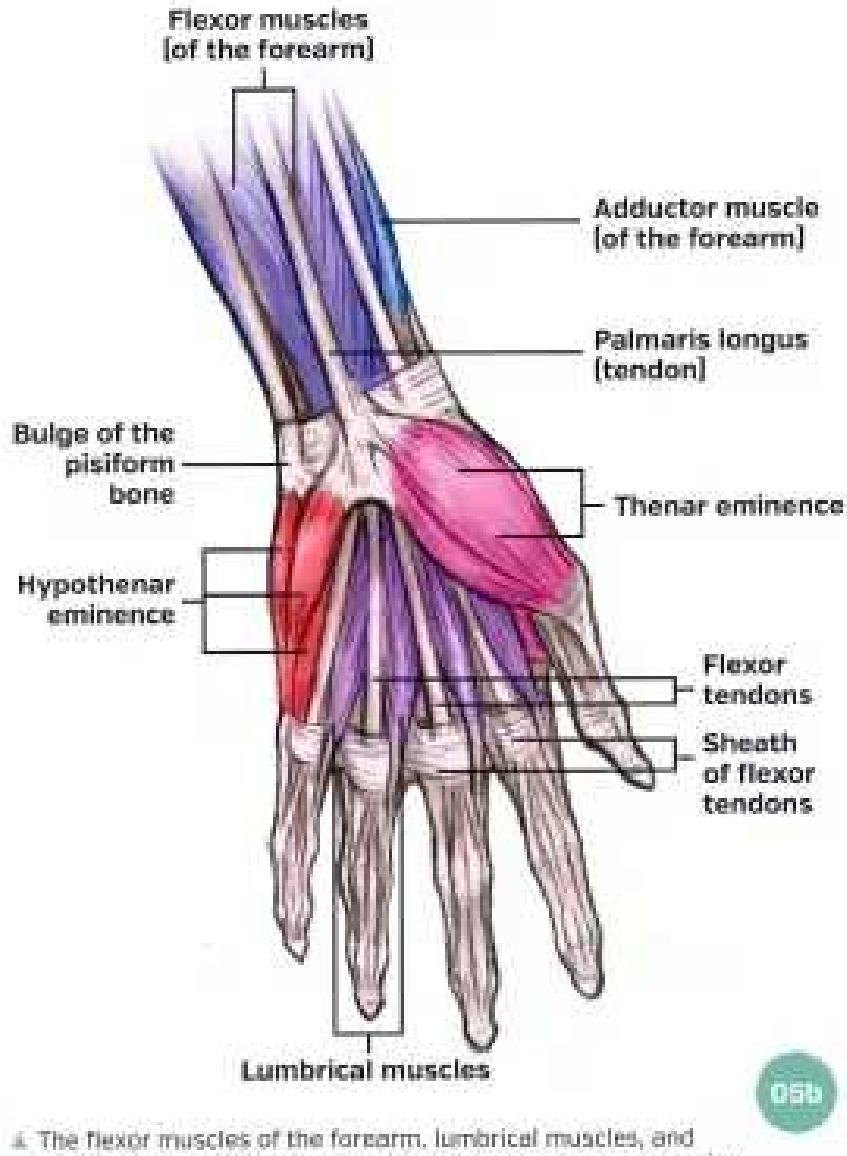
PROTIP
Dorsal and palmar

Dorsal is the upper view of a hand or foot; it is related to the biological meaning of dorsal relating to the back or upper side. When talking about the hands, the opposite is **palmar**, which refers to the palm-side view.



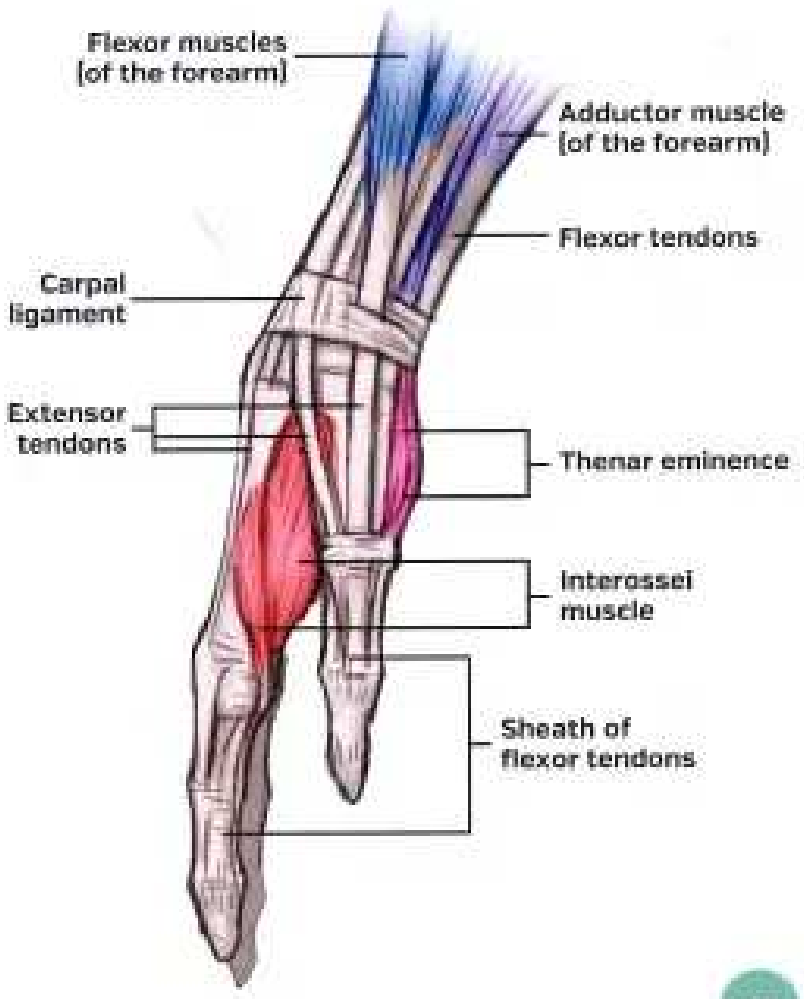
05a

▲ The extensor muscles of the forearm, interossei muscles, and extensor digitorum tendons can be seen in a dorsal view



05b

▲ The flexor muscles of the forearm, lumbrical muscles, and flexor tendons of the hand can be easily seen in a palmar view



05c

▲ Many tendons and ligaments surrounding the thumb are revealed in a lateral view

Drawing an archetypal figure

2D female

Part 04 | Lighting the skin

By Chris Legaspi

Concept artist and oil painter

The skin is the largest organ in the human body and it covers the body's entire surface. It hides a lot of the anatomy it covers, especially where the fat pads sit over the muscles and bony landmarks. However, there are still parts of the anatomy that can be observed through the skin. These areas are the key landmarks that artists must study. To help me study these landmarks, I like to use light and shadow to reveal the anatomy and forms.

Looking at the body from different angles really helps to deepen our understanding of the human form. As well as looking at the body as a whole, we should pay close attention to the head and face, focusing on the way the features cast shadows.

I like to use a soft, ambient light because it produces soft shadows and highlights without too much contrast. The forms don't stand out strongly, but the overall surface quality of the skin can be observed.

I also like to use a single source light, also known as a spotlight. Spotlights produce a high contrast of dark shadows and bright highlights. The light makes the silhouette and anatomy more visible and easier to observe.

01: Ambient light – full body shading

We have studied the relevant anatomical features of the human figure in detail, so now we can look at how it all comes together. The complex anatomy and skin lead us to a well defined and realistic female figure. We'll begin with a soft, ambient light. This light does not have dark shadows or high contrast so it will allow us to see the smooth surface quality of the skin and what lies underneath. Looking at the body from the front [fig 01a], we can see how the light and shadow reveal many anatomical forms beneath the surface of the skin. At the neck and shoulders, muscles such as the

01a

▲ Anterior view with ambient light

01b

▲ Lateral view with ambient light

01c

▲ Posterior view with ambient light

02a

▲ The bony landmarks of the skull are prominent

02b

▲ The shape of the nose is best seen in profile

02c

▲ You can see the back of the ear and how it connects to the skull

deltoids and sternocleidomastoid and the landmarks of the clavicle are visible.

One of the most noticeable anatomical differences between the male and female form are breasts, which are composed of fat and breast tissue covered by skin. They sit on top of the pectoralis muscles. Below the breasts we can clearly see the sternum and costal ribs. As this is a lean model we can also see the abdominals, obliques, and serratus muscles. In the lower body, the fat and skin that surrounds the knee joint create interesting shapes and landmarks.

In profile [fig.01b], the breasts protrude out from the chest. Note that they form a soft curve and that they are mostly made of fat, not bone, and therefore are not pointy or rigid! You can clearly see the gentle S-curve described by the spine.

The neck and shoulders make some interesting shapes and shadows. You can see the clavicle and scapula landmarks, the deltoids on the shoulder and upper arms, and the trapezius connecting with the shoulder and clavicle. Again, as this is a lean model, we can also see the serratus muscles and costal ribs on the torso. Note how the gluteus and tensor fascia lata smoothly connect to the vastus lateralis muscle in the quadriceps.

From behind [fig.01c], the many subtle and complex forms of the back are revealed by the light and shadow. The complex shoulder joint, especially around the scapula, is revealed by the subtle highlights as the muscles bulge outward. The deep recesses of the trapezius and erector spinae are revealed by the soft shadows.

As you can see, observing the body in light and shadow helps us to study anatomy under the surface quality of the skin. Light and shadow on the skin also show how aspects of the anatomy smoothly connect and relate to one another.

02: Ambient light – head and face shading

The face is one of the most complex regions of the body. Underneath the skin there are numerous facial muscles, not to mention the skull. In this series of images we'll again use a soft, ambient light to help us explore the anatomy of the face and observe how it affects the surface of the skin.

From the front [fig.02a], I highlight the forms of the skull underneath the skin. See how the light and shadows define the shapes of the face. The skull is prominent in many areas, especially on the forehead, nose, and cheeks; the shape of the jaw defines the lower part of the face. To add a touch of realism I have added subtle surface details such as freckles, hairs, and pores of the skin.

In profile [fig.02b], the subtle highlights and shadows are most prominent on the cheeks, forehead, and nose. You can really get a feel for the character of the nose from this viewpoint and the way it casts a shadow on the philtrum and lips.

The sternocleidomastoid muscle gives definition to neck – you can clearly see where it connects to the skull behind the ear. The ear anatomy is full of dips and peaks and therefore has some very deep shadows, especially the entrance to the ear canal.

PROTIP
Don't forget the details

Remember to add both eyelashes and eyebrows; these can really sell a model.

Fig.02c shows the posterior anatomy of the ears and how they connect to the skull. They are not flat against the head – they protrude slightly. One the most important and noticeable landmarks is the protrusion of the 7th cervical vertebrae at the base of the neck. It is easy to see how the trapezius flows down the upper back from the base of the skull and widens at the shoulders.

In summary, when looking at the head and face in ambient lighting, we don't see many muscles in details. However,

what is very noticeable are the bony landmarks of the skull and vertebrae.

03: High contrast light – full body shading

Now we'll look at the body under high contrast lighting to produce greater contrasts between the highlights and shadows. This kind of light is great for showing form. With a strong spotlight, we can view many of the major landmarks and other useful points of anatomy.

First, we have the full body viewed from the front [fig.03a]. The spherical form of the breast is revealed by the dark shadow and the highlight on the rib cage and sternum show how much the rib cage protrudes outward to catch light. The rib cage also creates a dark shadow that covers the upper abdominal region. The lower abdominals and obliques protrude outward again into the light.

Next, we have the body in side view [fig.03b]. The first thing I notice is how the dark shadow reveals the almost spherical forms of the shoulder and breast. The rib cage casts a strong shadow over the obliques and abdomen. The gluteus muscles, tensor fascia lata, and vastus lateralis are revealed by the dark shadow.

From behind [fig.03c], the size and complexity of the back muscles can be seen. The muscles surrounding the scapula, like the trapezius and teres muscles, create interesting light and dark shapes. The massive gluteus maximus casts a strong shadow on the upper legs.

As you can see, a high contrast light on the body creates dark shadows that reveal forms. With a strong light, the major muscles of the body can be

03a

▲ The high contrast light reveals the forms of the breasts and knees

03b

▲ The gluteals and hip muscles also show their volume

03c

▲ The beautiful forms of the shoulder joint are revealed

04a

▲ You can see how deep the eye sockets go

04b

▲ The structure of the jaw bone is revealed in the shadow

04c

▲ You can clearly see the structure of the skull

easily seen through the skin. The light also shows how the forms and anatomy recede and then protrude out again.

04: High contrast light – head and face shading

The high contrast light really brings out the forms of the head and face. With this light we can fully explore the major planes, landmarks, bone structure, and anatomy of the head and face.

From the front [fig.04a], the strong spotlight quickly reveals the major forms of the head. The strong highlight on the forehead shows the spherical nature of the skull. The dark shadows in the eye socket show how deep the eyes are set in the head. The dark shadow and highlight on the cheekbones show how the bone affects light and shadow on the surface of the skin. The clear core shadow on the side plane of the cheek shows its box-like form as it turns away from the light. The dark shadow under the chin shows how much the chin protrudes outward.

In profile [fig.04b], I notice the spherical nature of the cranium at the back of the head. I notice how deep the eyes are set in the eye sockets and how much the nose and mouth protrude forward. I especially note the dark shadows created by the forms of the jaw bone. From behind [fig.04c], the spherical nature of the skull and cranium can be easily seen. Highlights reveal the interesting shapes of the ear. The highlights on the trapezius reveal their thickness and size.

To summarize, strong light and shadow really bring out the forms of the head and face. The plane changes created by the bone structure underneath are clearly visible on the surface of the skin. The dark shadows show the depth of the recessed forms like the eye sockets. The bright lights and highlights show how strongly forms such as the brow bones, nose, mouth, lips, and ears protrude from the face.

05: Half écorché comparison

In these final set of images, the diagrams will be cut in half to reveal the muscle anatomy beneath the surface of the skin. This view will show how the muscle anatomy affects light and shadow on the surface of the skin.

05a

▲ You can see which of the anatomical structures show through the skin

05b

▲ The lighting really highlights the contours of the back

From the front [fig.05a], I notice how much of the muscle anatomy can be seen. The large neck muscles and the clavicle are easily seen. The deltoids and pectoralis are easily seen even underneath the female's breasts. In the torso, the serratus and abdominals are visible on this lean model, as well as the bony protrusion of the sternum and the costal cartilage of the ribs. At the limbs, almost all of the major muscles can be seen, especially the biceps in the arms and the quadriceps in the legs.

From behind [fig.05b], the large trapezius dominates the upper back region. The spine of the scapula, the deltoid, and the teres muscles can be seen in light and shadow. The wide latissimus dorsi can also be seen through the skin. The most noticeable muscle is the massive gluteus maximus, which dominates the hip region.

When I examine the face in light [fig.05c], I notice that the bones of the skull are the most prominent and

05c

▲ This half écorché shows the bony landmarks of the skull

visible features. The facial muscles are relatively small and thin, so they are not as visible as the bone. For example the massive cheekbone and the layers of fat and skin hide the many intricate muscles in the cheek.

Comparing the muscle anatomy to the surface of the skin is a great way to study anatomy and form. This comparison helps you to appreciate the bones, muscles, and skin and how all the anatomy fits together. This view also reminds us of the anatomy that creates visible landmarks on the surface of the body.

2D reference gallery

In this first gallery, we have gathered together some incredible sketches of the human form in different poses to inspire your modeling. Each of the talented artists has provided written notes about each pose's points of interest, helping you to observe and analyze the body in new ways.

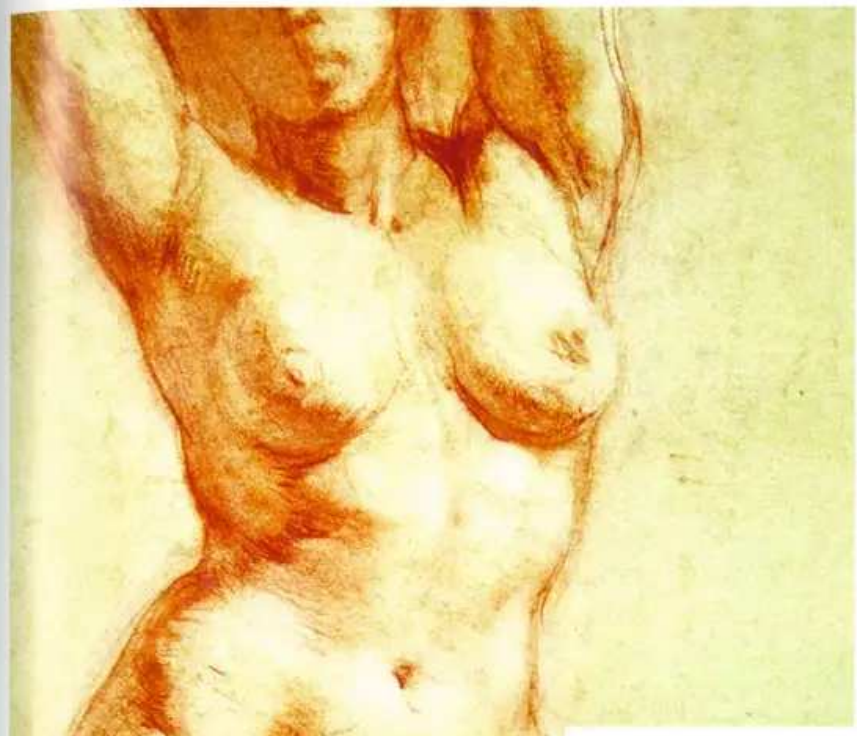
Stephen Perkins
www.stephenperkinsart.net

Female figure study
Top right: This is a figure study showing the use of straight lines to create a contour. This is somewhat unrefined so you can see very clearly how the straights created the edges. That said, as you break down the edges into smaller straights, you quickly get something that looks very organic.

Erik Gist
www.erikgist.com

Torso
Bottom right: Looking at the torso from the front, you can see the way the abdominal muscles bridge the gap between the rib cage and the pelvis. The key to conveying the proper dynamic of the torso is how you execute this area.

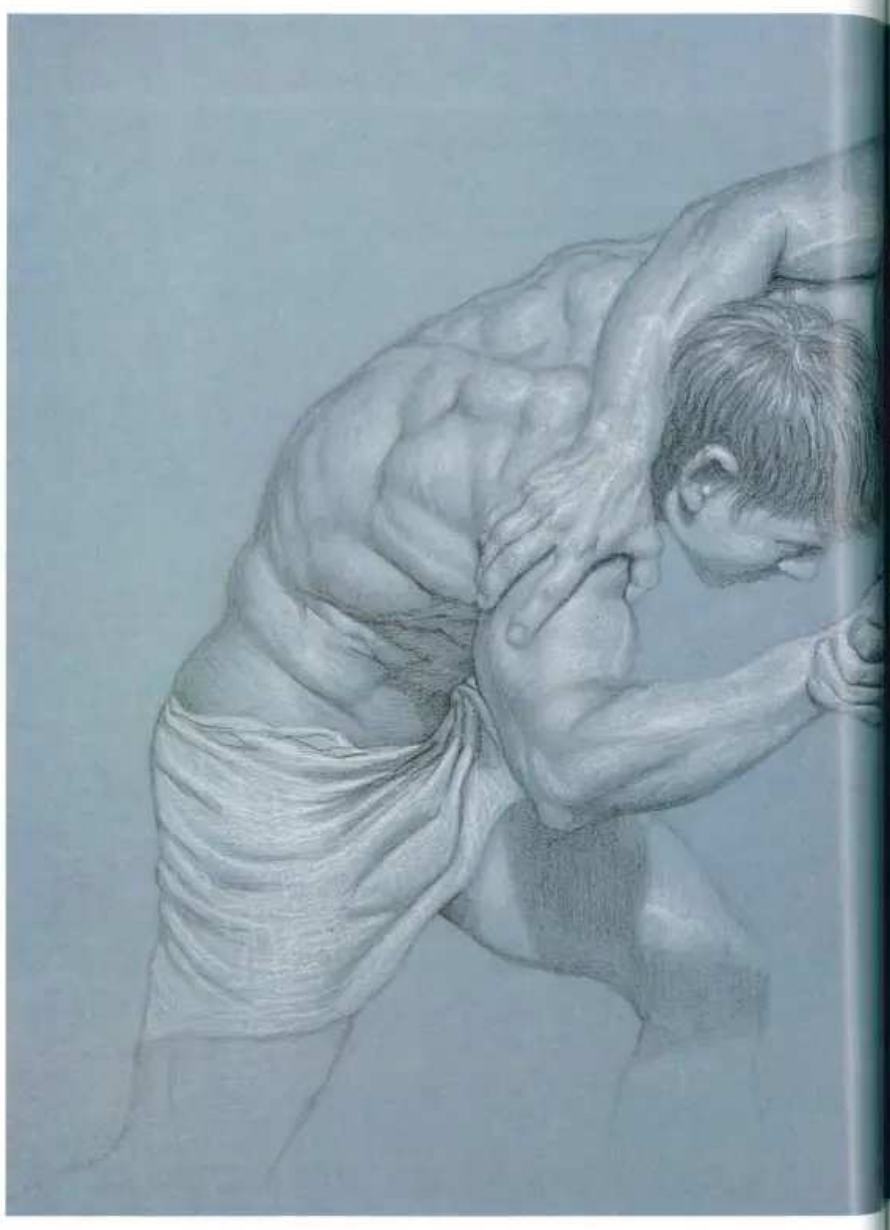
Another key characteristic of the torso, especially in an extended posture, is the distinct diagonal striations of the external oblique. These run from the serratus to the outer edge of the rectus abdominis. When the back is arched, notice the way the external oblique pinches and overlaps itself slightly. Always look for the unique staggering of the rectus abdominis; this will give your drawings a sense of authenticity.



James Sondow
www.sondowsculpture.com

Stomach drawing
Here the line between the superior anterior iliac spines and the line drawn between the greater trochanter of the model's left femur and her left iliac spine form a clear 90-degree angle. This right angle is the corner of the immutable box formed by the pelvis, whose strong diagonal thrust is necessarily perpendicular to its middle line. The torso leans in an opposite diagonal also constructed with a large clearly constructed box cut centrally by the midline bisecting the breasts. The midline of the body, while appearing curved, must actually be straight at the pelvis and torso and only truly bend in the mid-section

where the abdominal muscles mitigate the transition from one diagonal to the other.



Rita Foster
www.ritafoster.blogspot.co.uk

Roman-style wrestlers, 2009, *black & white charcoal on blue toned paper*
In this pose the torsos are crouched and flexed, creating bulbous muscle shapes on the back and creased or compression lines in the abdominal region. Whenever one side of a body part is flexed, the opposite side is always compressed. You can also see the same thing happening in the cloth of the figure on the left. While one side is stretched (on his right leg) the area of the left leg is compressed and creating folds.

James Sondow
www.sondowsculpture.com

Standing Ilustian anatomy
Far left: The pronounced resting leg has a clear anatomical curve. The heightened contrast marks the contact of the model's left index finger with skin where you find the superior anterior iliac spine, a commonly emphasized landmark, where the sartorius finds its origin.

As we follow the sartorius, it spirals down the leg, separating two functional groups – the adductors and the extensors – before wrapping around the medial condyle of the model's left femur and inserting into the medial surface of the superior shaft of the tibia.

From here the anatomical line continues down the anterior border of the tibia itself, whose entire front face can be seen close to the skin. The line curves again around the medial malleolus of the tibia (inner ankle) before disappearing under the foot.

This line helps bind the various forms of the leg, especially as the thrust of the upper leg, knee, and lower leg all move in diagonal opposition to each other.

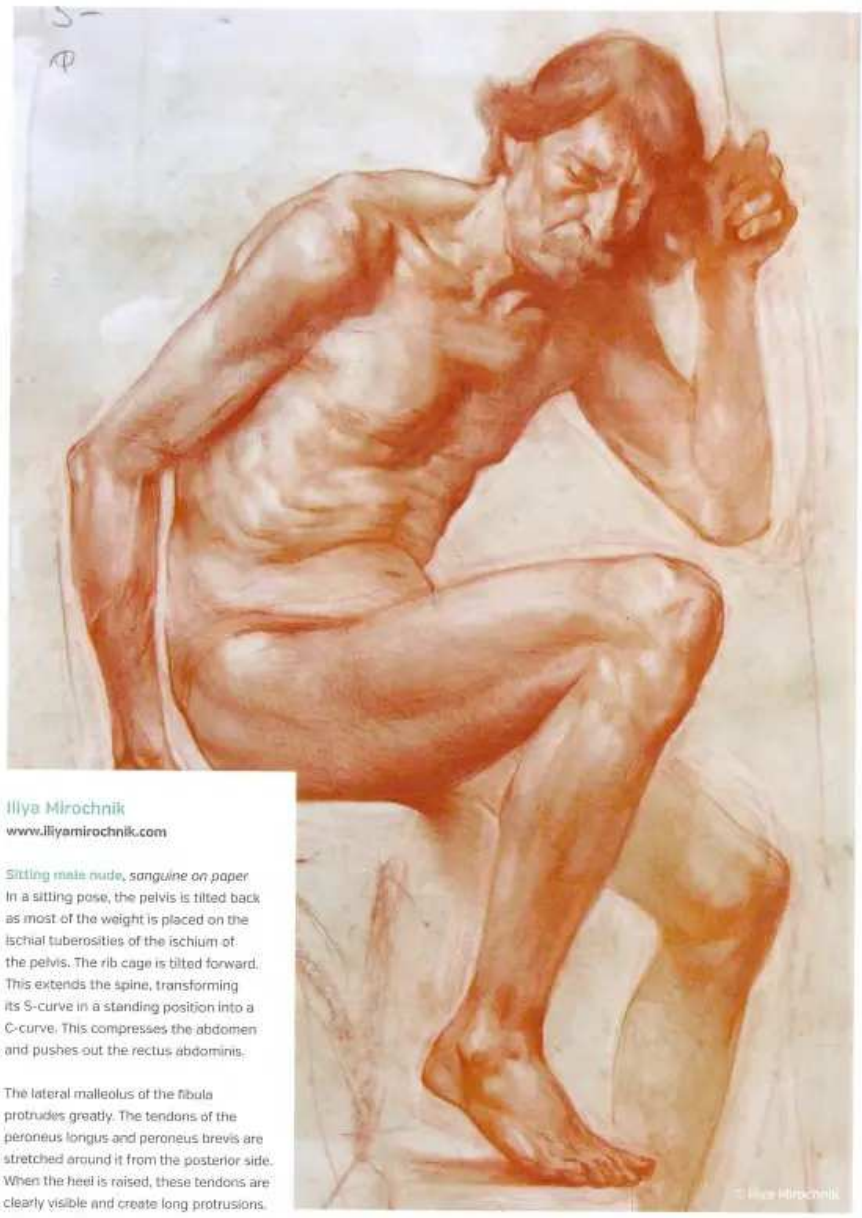
Standing female nude
Left: In any traditional *contrapposto*, the entire model's weight is supported by the standing leg. One must imagine a vertical weight line passing through the center of the neck and it must end at the instep of the standing foot. If that line falls too far to either side of the standing foot, the model will appear to be falling.

Because the entire weight of the body is essentially hanging from the standing leg, the leg itself acts like a spring. Imagine a stick with a great weight on it bowing in the center.

Charles Mlano
www.southernatelier.org

Man reaching, *charcoal on paper*
Below: Through this sketch I learned how the anatomy of the back changes as the arm is raised. It is important to understand how one action creates reactions that reverberate throughout the body. Be sure to understand the direction of both the posterior spine of the scapula and the medial border which turns laterally when the arm is raised. Look carefully for the evidence of these landmarks.

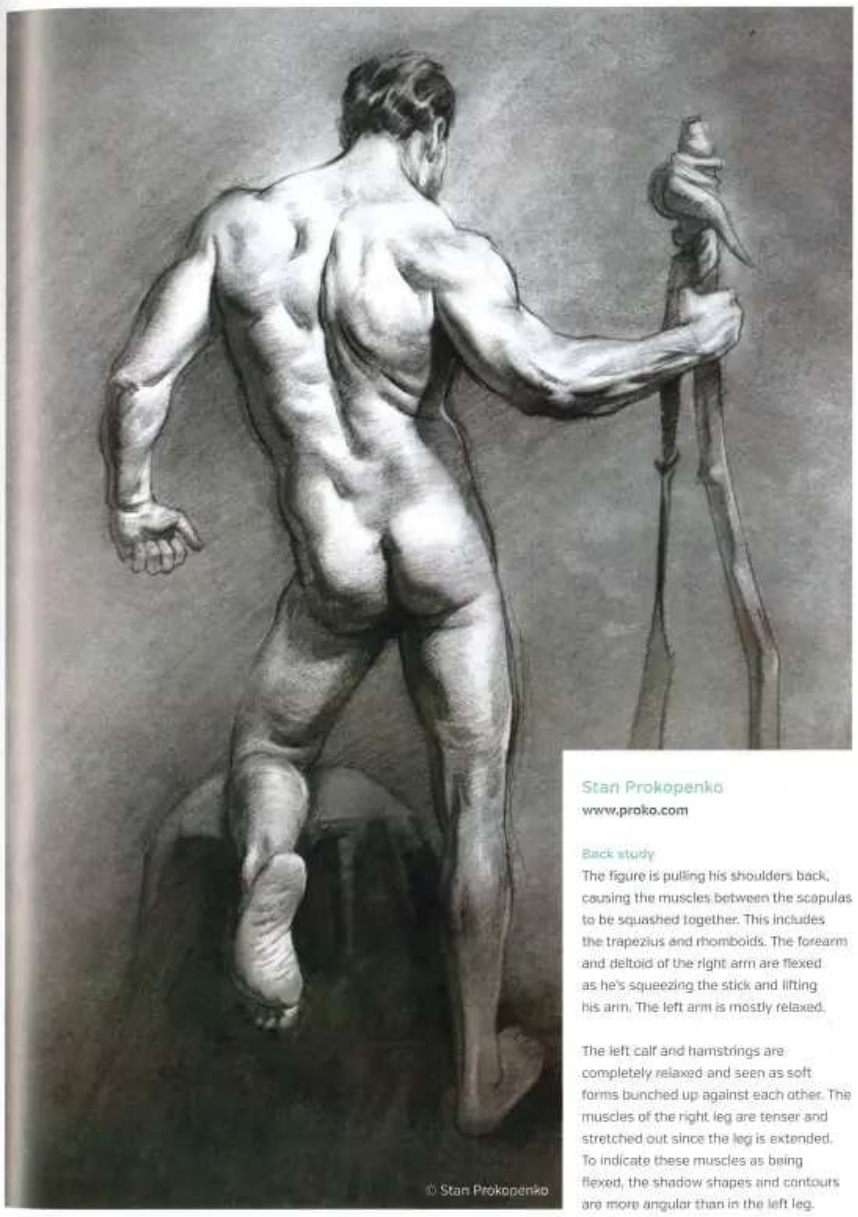
Knowledge of the purpose or action of each muscle helps in understanding the complexity. For instance, knowing that the acromial portion of the deltoid abducts the arm gives a reason for the volume of that form in this position. Knowing that the posterior deltoid is responsible for pulling the horizontal arm backward tells us that the muscle is somewhat flattened.



Illya Mirochnik
www.iliyamirochnik.com

Sitting male nude, *sanguine on paper*
In a sitting pose, the pelvis is tilted back as most of the weight is placed on the ischial tuberosities of the ischium of the pelvis. The rib cage is tilted forward. This extends the spine, transforming its S-curve in a standing position into a C-curve. This compresses the abdomen and pushes out the rectus abdominis.

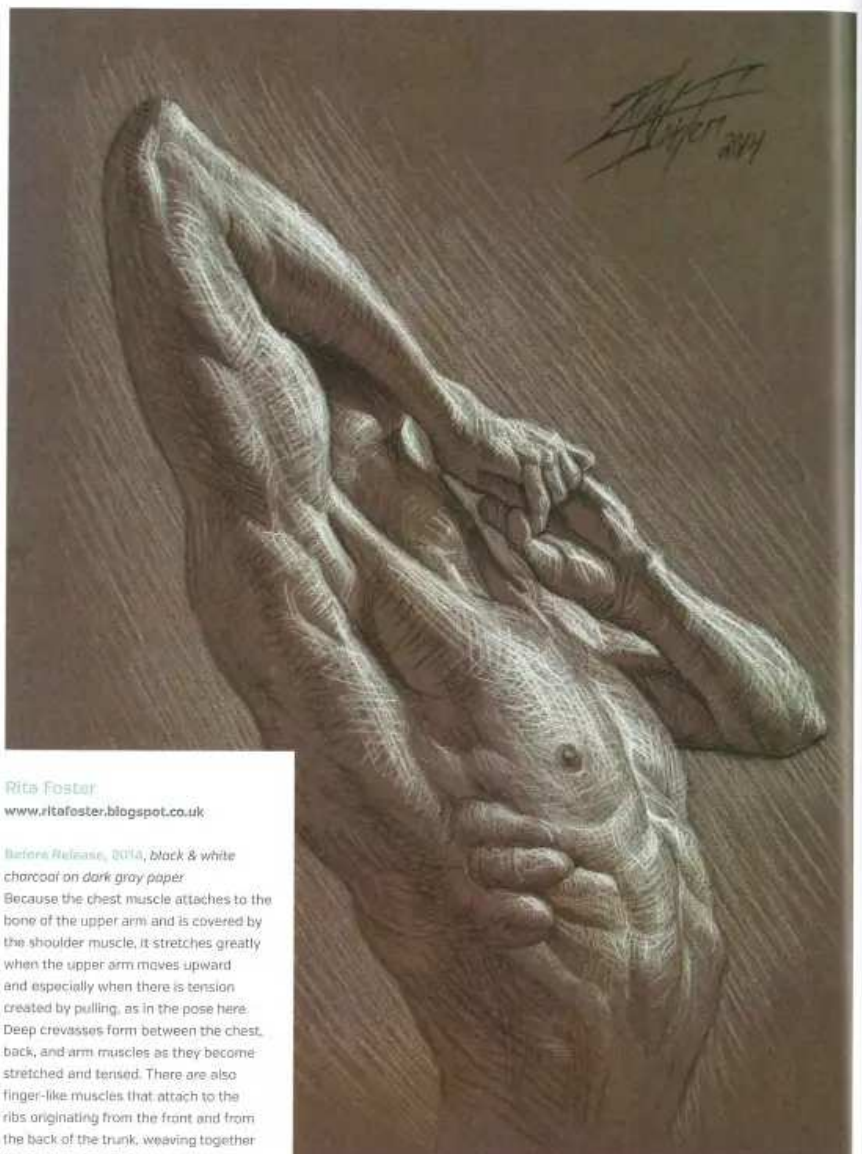
The lateral malleolus of the fibula protrudes greatly. The tendons of the peroneus longus and peroneus brevis are stretched around it from the posterior side. When the heel is raised, these tendons are clearly visible and create long protrusions.



Stan Prokopenko
www.proko.com

Back study
The figure is pulling his shoulders back, causing the muscles between the scapulas to be squashed together. This includes the trapezius and rhomboids. The forearm and deltoid of the right arm are flexed as he's squeezing the stick and lifting his arm. The left arm is mostly relaxed.

The left calf and hamstrings are completely relaxed and seen as soft forms bunched up against each other. The muscles of the right leg are tenser and stretched out since the leg is extended. To indicate these muscles as being flexed, the shadow shapes and contours are more angular than in the left leg.



Rita Foster
www.ritafoster.blogspot.co.uk

Before Release, 2014, *black & white charcoal on dark gray paper*
Because the chest muscle attaches to the bone of the upper arm and is covered by the shoulder muscle, it stretches greatly when the upper arm moves upward and especially when there is tension created by pulling, as in the pose here. Deep crevasses form between the chest, back, and arm muscles as they become stretched and tensed. There are also finger-like muscles that attach to the ribs originating from the front and from the back of the trunk, weaving together where they meet. These muscles are

Erik Gist
www.erikgist.com

Arm 02
Top left: When looking at a joint in flexion, observe the way the muscles overlap and radiate out at the point of greatest compression. In the case of the elbow, look at the ridge muscles and how they radiate out from the crook of the elbow and overlap one another as well as the brachialis anticus. In a posterior view of the armpit you should look for the radiating pattern of the deltoid and lesser scapular muscles.

Arm 01
Left: Look for the way the muscles of the upper arm twist and wrap around one another. For instance notice the way the deltoid spirals around the triceps, or the way the long head and lateral head of the triceps wrap around the medial head. In the forearm notice how the ridge muscles appear to twist around the extensor muscles. All of this twisting and wrapping will

Stephen Perkins
www.stephenperkinsart.net

Arm study
Top right: The anatomy of the arms is very complex, especially when you get past the elbow, and this is because of the hand. There is an old saying in art that "the hand begins at the elbow". In terms of the muscles, the flexors and extensors of the hand and fingers either emanate from the medial epicondyle or the lateral epicondyle of the humerus.

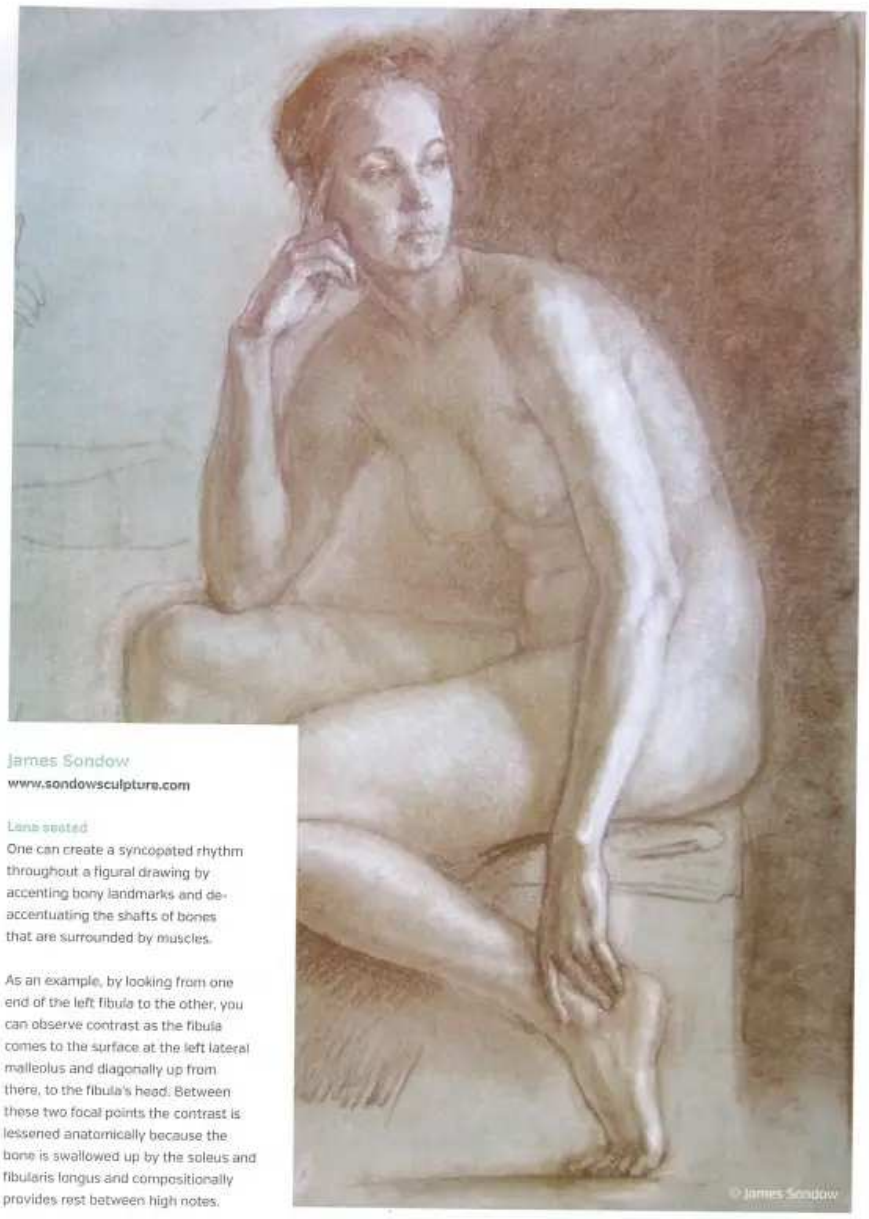
Hands and fingers are capable of a myriad of movements. Just remember that all the art that has been created in human history, all the music played and everything involving delicate hand work, has been done with these appendages. The muscles and anatomy correspond in complexity to the tasks.

To simplify the process of drawing arms you need to not just study their form but think of them as larger forms and patterns you can memorize. Our brains can only

also much more pronounced when the trunk muscles are stretched.

create a greater sense of unity and dimensionality when designed correctly.

take in so much complexity, so you should simplify things into larger groups.



James Sondow
www.sondowsculpture.com

Lena seated
One can create a syncopated rhythm throughout a figural drawing by accenting bony landmarks and de-accentuating the shafts of bones that are surrounded by muscles.

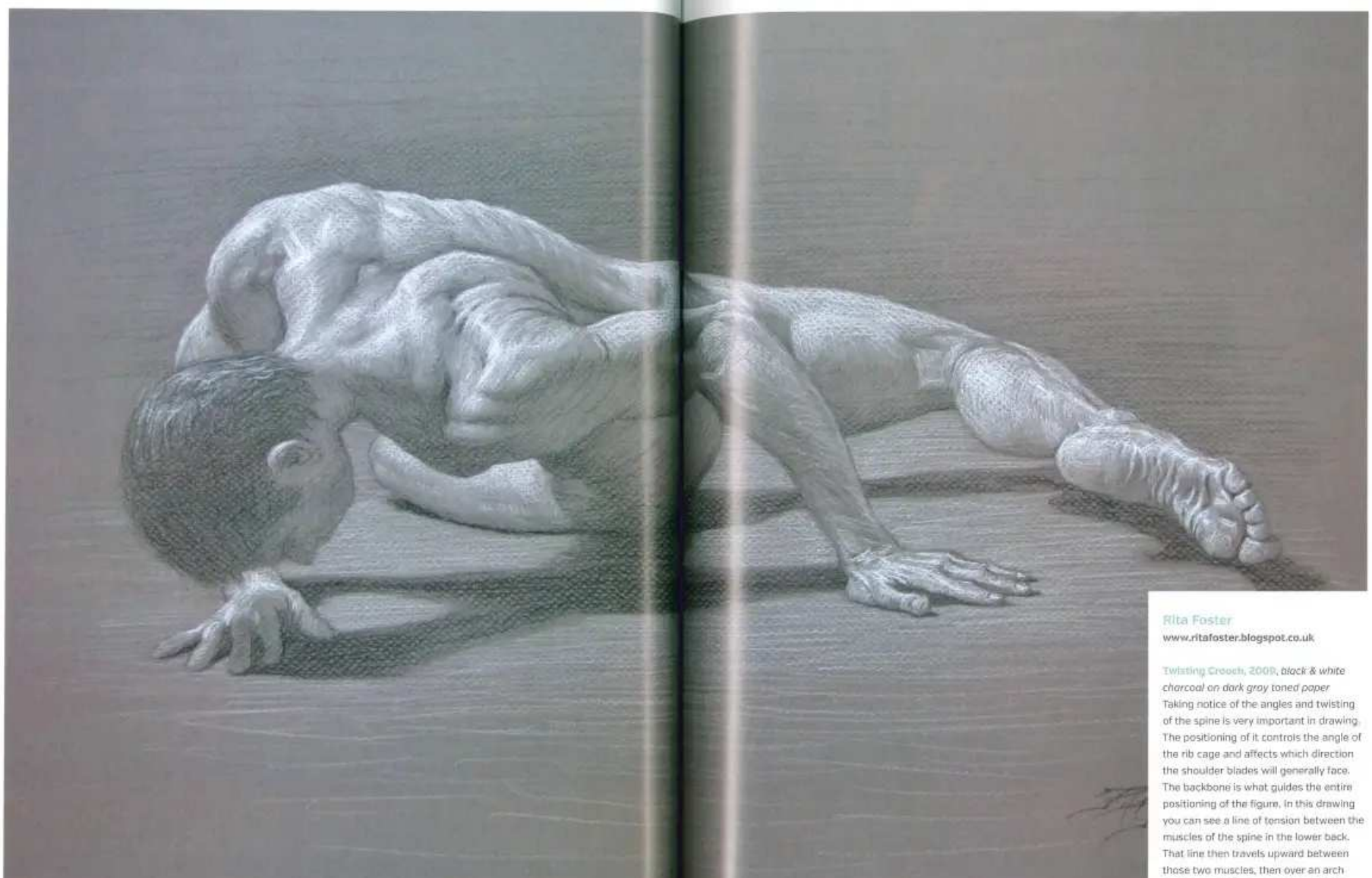
As an example, by looking from one end of the left fibula to the other, you can observe contrast as the fibula comes to the surface at the left lateral malleolus and diagonally up from there, to the fibula's head. Between these two focal points the contrast is lessened anatomically because the bone is swallowed up by the soleus and fibularis longus and compositionally provides rest between high notes.

Iliya Mirochnik
www.iliyamirochnik.com

Study of Nikolai, *sanguine on paper*
There are four main depressions around the neck and the shoulder girdle that help separate the main muscle groups. They are the lesser supraclavicular fossa, the greater supraclavicular fossa, the subclavicular fossa, and the occipital triangle (which is not so much a fossa, but is an important space that lies on the side of the neck between the sternocleidomastoid and the trapezius). They help create a feeling of movement and add life to the entire upper body.

The most important of the muscles in the neck region is the levator scapulae that tends to merge with the trapezius as it moves down from the neck into the shoulder.

The bones of the knee are very visible in any of the knee's positions. Specifically, the bent knee allows for the clearest visibility of the lateral and medial condyles of the humerus, the lateral and medial condyles of the tibia, the tibial tuberosity, and the head of the fibula.



Rita Foster
www.ritafoster.blogspot.co.uk

Twisting Crouch, 2009, *black & white charcoal on dark gray toned paper*
Taking notice of the angles and twisting of the spine is very important in drawing. The positioning of it controls the angle of the rib cage and affects which direction the shoulder blades will generally face. The backbone is what guides the entire positioning of the figure. In this drawing you can see a line of tension between the muscles of the spine in the lower back. That line then travels upward between those two muscles, then over an arch of the upper back and in between the

© Rita Foster

shoulder blades that compress together, finally ending up at the base of the skull.

© Rita Foster

Rita Foster
www.ritafoster.blogspot.co.uk

It Still Remains, 2013, *black & white charcoal on light gray paper*
Pulling creates muscle tension. Here the model's hand pulls down on his neck while he pulls his neck away in the opposite direction; this creates incredible tension. As his left hand pulls down against his trapezius and neck muscles, it creates pressure against those muscles and also tension in his hand and forearm. The neck muscles bulge out around the contour of the tensed hand that squishes into the flesh. The skin is pulled taut over the hand and forearm muscles and tendons, which make the underlying forms clearly visible and easy to identify.

© Stephen Perkins

© Erik Gist

Stephen Perkins
www.stephenperkinsart.net

Torso study
Top left: Light that rakes the surface will pick up the slight nuances and changes of form. In drawing, those forms register as tone changes so you have to be adept at gauging values. In sculpture of course the forms are in true 3D. In either case lighting is critical.

You will see that on the edge of the forms there are many straight lines. The human body is infinitely complex, but if you try to draw it with curves as it appears, it can end up looking like jelly. You need structure and that means planes.

Erik Gist
www.erikgist.com

Torso
Top right: Note the movement of the shoulder blade in regard to the arm. As the arm draws forward it pulls the shoulder blade laterally away from the spine. Always look for the tell-tale "saw tooth" pattern of the serratus emerging from beneath the latissimus. It is particularly noticeable here, as this is the muscle that pulls the shoulder-blade forward.

Stan Prokopenko
www.proko.com

Torso study
Right: In this drawing I tried to make most muscles active to create a feeling of tension. I demonstrated a lot of zig-zags in the tones. Contour lines as zig-zags create tension; curves create calm. Since he's putting half of his weight on his hands, most of the muscles in the arm are flexed. You can see the clear separation of the triceps heads and muscle fibers in the deltoid. He's pressing his arm against his body creating wrinkles along the chest originating at the armpit. This helps with that overall feeling of tension.

© Stan Prokopenko

Stan Prokopenko
www.proko.com

Yoni
In this pose, the model is leaning forward, causing compression and folding in the abs. You can see the horizontal creases across the waist showing this tension. He's subtly reaching with his right arm and facing his palm forward, which causes the flexor group of his forearm to activate. The triceps and deltoid are also active.

The forms of the latissimus and trapezius are slightly exaggerated because they are at the focal point of the drawing and make him appear more powerful in the upper body. I darkened the tones and

Charles Miano
www.southernatelier.org

Study of Achilles, *red chalk on paper*
Here you can see a C-curve line of action which represents abstractly the large movement of the figure. When working on a figure drawing, make sure you define the main line of action for your pose. By doing this you avoid wasting time on a figure that will ultimately lack emotional impact. Emphasizing the bone structures grounds the rhythms and also provides a strong foundation for the muscles.

It is important not to exaggerate the symmetry of the muscles. Be careful not to treat them as bumps and

lowered the contrast in the lower legs and face to pull the viewers' eyes to the torso.

© Stas Prokopenko

© Charles Miano

bubbles, as this diminishes the natural organic quality of muscle fiber.

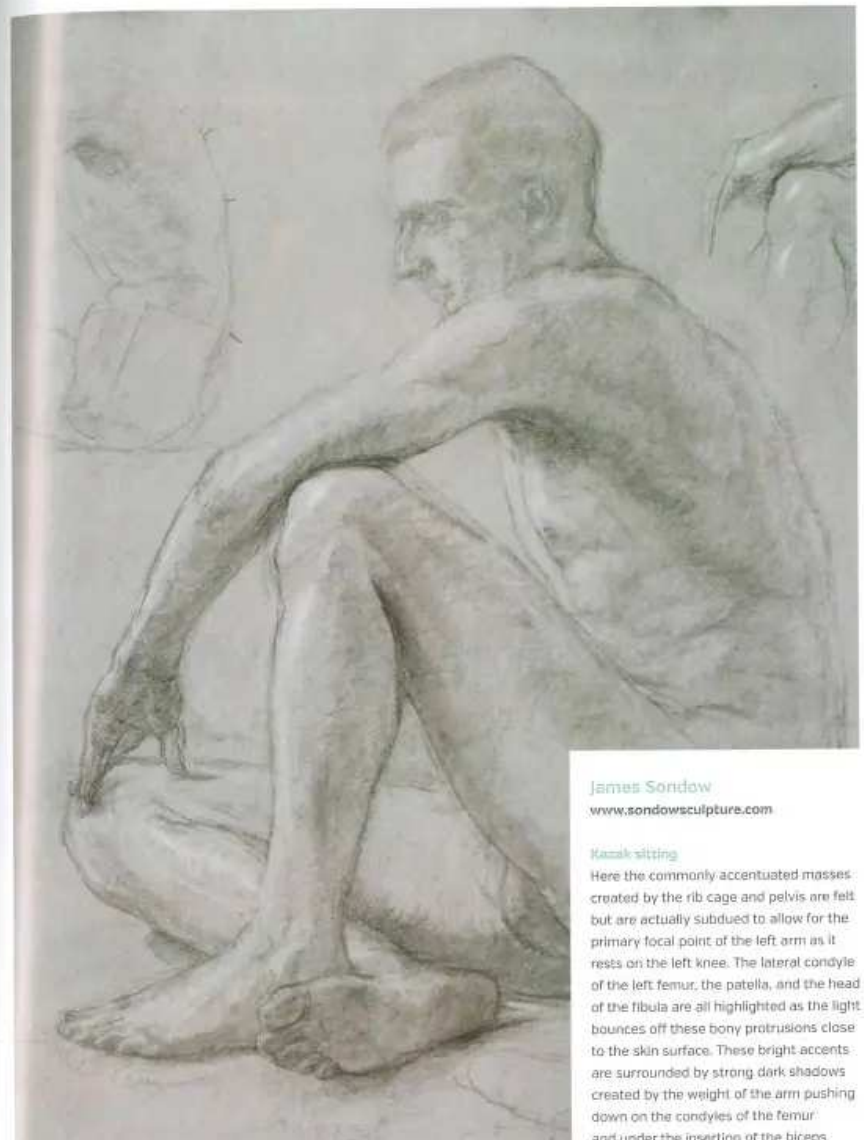
Iliya Mirochnik

www.iliyamirochnik.com

Standing male nude, *charcoal on paper*
When beginning a standing pose, it is important to establish the tilts of three important elements: the pelvis, rib cage, and the anchoring leg. In traditional *contrapposto*, the pelvis and the rib cage are tilted in opposite directions. Another way to look at this is that the vertical axis of the weight-bearing leg and the horizontal axis of the pelvis create an acute angle at the greater trochanter, while the vertical axis of the rib cage and the leg are nearly parallel.

To accentuate the plasticity of the standing *contrapposto* pose, the shoulder girdle (scapulae) is crucial in accentuating the tilt of the rib cage. When the arm is raised, the scapula rises with it. You must differentiate between the horizontal axis of the rib cage and that of the scapulae. If the arm opposite the weight-bearing leg is lifted, the movement is heightened. If the arm on the same side as the weight-bearing leg is lifted, the movement is subdued; the axis is leveled out as it nears the horizontal line.

A similar thing can be said concerning the gluteus maximus muscles, though there is less movement and they always help in forcing the tilt of the pelvis. The gluteus maximus of the weight-bearing leg is always tense and pushed up by the hamstrings group of the upper leg. The other gluteus maximus muscle is then relaxed and hangs lower, once again accentuating the horizontal tilt of the pelvis.



Rita Foster

www.ritafoster.blogspot.co.uk

Despair, 2012, *black & white charcoal on dark gray paper*
With the legs being at an angle that creates compression on the back of the knees, you can see a shape appear on the outer side of the figure's left calf. As the muscles of the calf press against the back of the thigh, it creates pressure that pushes the muscle outward. You can also see how that even affects the cast shadow of the calf. It is a hard-edged shadow at the point of compression between the calf and thigh, and softens or lightens as it stretches downward and across the rest of the thigh.

Stan Prokopenko

www.proko.com

Rob
The muscles in this drawing are relaxed because the figure is in an inactive seated pose. The triceps are seen as one soft form affected by gravity. Some muscles however need to be tense to stabilize the torso and keep him vertical, such as the erector spinae muscles in the lower back.

Compression of the gluteus maximus, gluteal fat, and skin on the seat causes a flattening of the bottom edge and zig-zag-shaped tones on the back plane. The light in this drawing shows off the forms of the upper back muscles

James Sondow

www.sondowsculpture.com

Kazak sitting
Here the commonly accentuated masses created by the rib cage and pelvis are felt but are actually subdued to allow for the primary focal point of the left arm as it rests on the left knee. The lateral condyle of the left femur, the patella, and the head of the fibula are all highlighted as the light bounces off these bony protrusions close to the skin surface. These bright accents are surrounded by strong dark shadows created by the weight of the arm pushing down on the condyles of the femur and under the insertion of the biceps femoris into the head of the fibula. The

really well. Most prominent is the diamond shape of the trapezius.

© James Sandow

contrast of the highlights and shadows bring the knee into the foreground.

Sculpting an archetypal figure

Sculpting an archetypal figure

3D male

Part 01 | Basic form

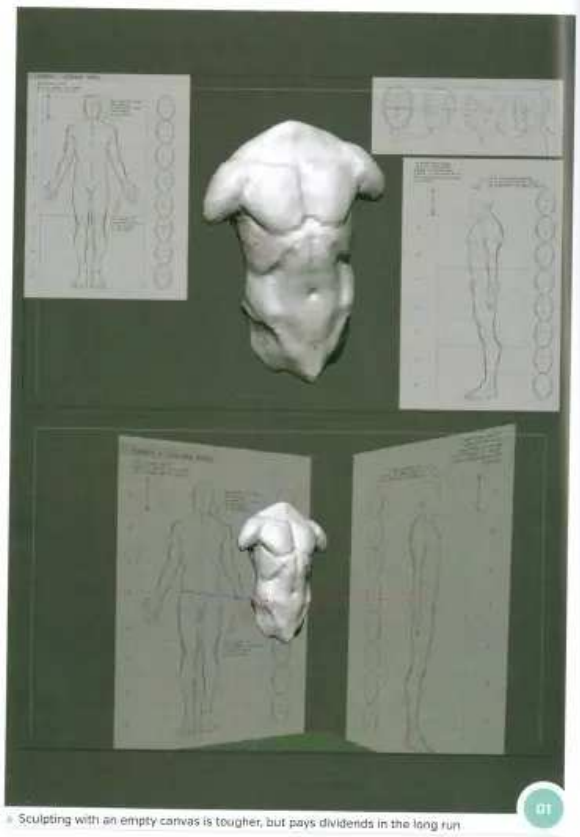
By Djordje Nagulov

Freelance modeler

Over the course of three parts, we will be sculpting a full male figure in a relaxed T-pose from start to finish. This first part will deal mainly with the creation of a solid base sculpt. We will pay particular attention to form, gesture, and silhouette, as well as the ways in which these principles influence each other. We'll also touch upon several ways the male figure differs from the female one, and how this affects the process of sculpting.

To start, we'll go over several different ways of blocking out an initial form while discussing their pros and cons. We will then proceed to shape this "digital clay" into an anatomically accurate base figure. We will build up the human figure in sections, going over each limb in turn. Close attention will be paid to structure, proportion, and bony landmarks – getting these right at this stage is critical for a natural-looking end result.

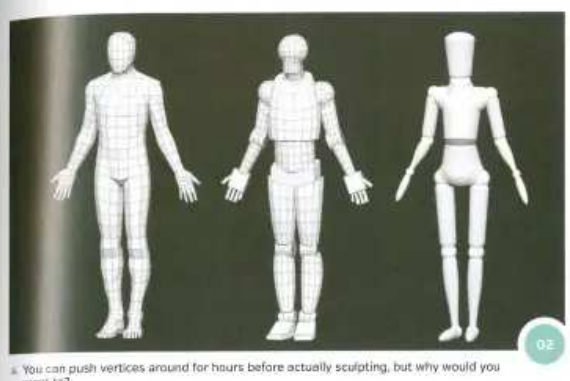
Finally, we'll tentatively sketch in the largest muscle groups on top of the skeletal structure, providing a solid base upon which to build detailed musculature later. As a finishing touch, we'll adjust proportions and do a quick overview of the full figure.



▲ Sculpting with an empty canvas is tougher, but pays dividends in the long run

01: Working environment

First, it's important to discuss how we will set up our reference. Some artists like to sculpt directly over reference planes, whereas others put their references to the side (or on a separate monitor) and carefully study the proportions. Both approaches have their merit; which one working in a production environment or on your own time. Keep in mind that up the process, but tackling an empty canvas trains the eye in the long run. Also



▲ You can push vertices around for hours before actually sculpting, but why would you want to?

02: Block-out methods

There are several tried-and-true ways of blocking out a human figure: you can make a base mesh in classic modeling software such as 3ds Max; you can quickly bash together geometric shapes; or you can use software-specific tools such as ZSpheres and mannequins in ZBrush.

Most approaches are equally valid and provide the same end result, which is a basic humanoid mesh with evenly distributed polygons to start sculpting from. However, unless edge loops are a requirement from the get-go, artists just tend to grab a lump of digital clay to quickly mess around with, and sort out the technicalities later.

▲ Once the sharp edges are shaved off, shaping the rib cage and the pelvis provides a basic road map for the torso

03: Creating the torso

Starting from a box provides you with defined sides, which can help keep your sculpt organized once you introduce the many plane changes of the body. Of course, you should immediately whittle down the sharp corners and hint at the skeleton underneath.

The rib cage takes up roughly two thirds of the torso and is basically egg-shaped. The pelvis, which takes up the lower third, looks more like a box and sits at a slight backward angle. Once the base of the neck is extruded up at the top, the signature lazy S-curve of the spine starts to emerge.

▲ At this stage the main landmarks are way too exaggerated, but will be toned

04: Landmarks of the torso

The lower edge of the rib cage delineates the top of the abdomen, while the iliac crest functions like a bowl in which the abdomen sits. At the front of the hip, the anterior superior iliac spine is hinted at – a crucial landmark for both the legs and torso.

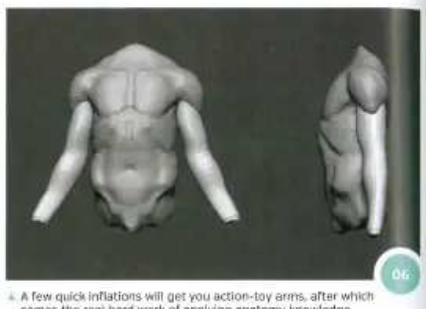
On the back, the scapulae are quickly sketched in, each taking up roughly a third of the area across. The spine is carved in fairly deep; in women this angle is usually shallower because the surrounding muscle isn't as developed. The clavicles are also added, taking care

you pick often depends on whether you're working directly over an image will speed canvas trains the eye in the long run. Also, you can never have too many references!

down gradually as the sculpt continues

to give them their characteristic S-shape.

▲ With the primary muscle forms sketched in, next it's time to move on to the arms, legs, and head



▲ A few quick inflations will get you action-toy arms, after which comes the real hard work of applying anatomy knowledge

05: Adding some muscle

It's important not to go overboard with muscles at this early stage, which is a classic beginner's mistake. Only add bulk where it describes the form; don't get bogged down in the details. The pectorals hang from the clavicles and drape over the rib cage, tucking under the deltoids. Sitting on top of the iliac crest are the obliques, while on the back the huge latissimus dorsi give the male torso its triangular shape. The mass of the trapezius extends above the scapulae, sitting on the shoulders and tapering into the neck.

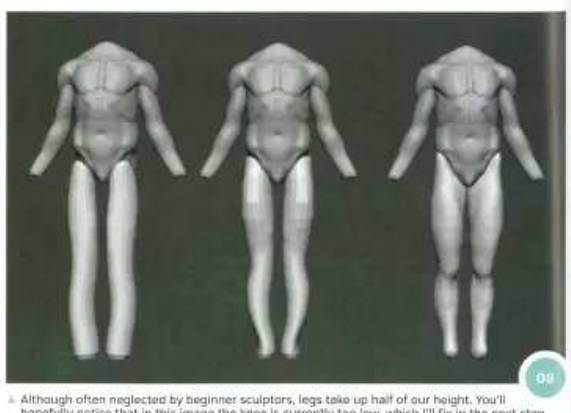
06: Slotting in the arms

Create the limbs with quick, gestural strokes. Note the slight bend at the elbow from the front – the extended arm isn't actually completely straight and the angle is even more pronounced in women. Once the basic tube is drawn, the cylinder is given shape by moving and inflating the forms. Add a hint of bicep and imply the plane change in the forearm where the brachioradialis curves around the bone. Equally important is the small bump on the inside of the elbow (the medial epicondyle). Keep in mind that the elbow and epicondyles sit in a line when the arm is straight.

07: Refining the arms

Arms are actually among the most difficult areas of the body to get right, specially the connection between the upper and lower arm at the elbow. Visualizing them as two chain links at 90

▲ We know the basic forms, but the devil is in the details



▲ Although often neglected by beginner sculptors, legs take up half of our height. You'll hopefully notice that in this image the knee is currently too low, which I'll fix in the next step

degrees to each other helps. The elbow is a transitory area, with many muscles traveling through from one half of the arm to the other. Note where the inside and outside highest points sit on the forearm. We should also add the mass of the triceps and the bump of the elbow.

08: Inserting the legs

Legs are formed in much the same way as the arms – note the wavy gesture. The distinctive belt of the sartorius is sketched in, curving from the front of the hip around the thigh and then to the inside of the knee. The knees are just put in as bumps for now. Forms are difficult to get right, so rotate and adjust constantly. What looks correct from one angle won't look correct after just 30 degrees' rotation. The legs are the most complex area after the arms, therefore putting in the time to get the basic shapes right at this stage is crucial.

▲ The inherent complexity is starting to emerge, as different masses flow around one another and change form constantly

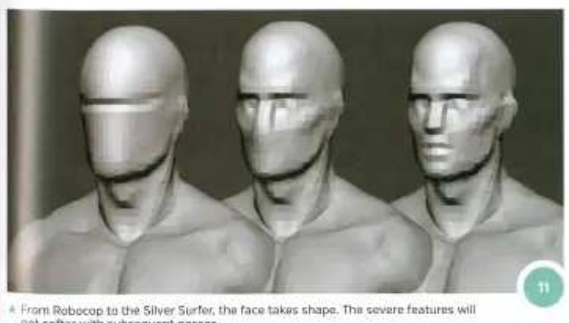
09: Refining the legs

The gluteus is a surprisingly large muscle. It slots in underneath the iliac crest and extends some way down the back of the thigh. The easiest way to visualize the gluteus is as a large bean sitting at an angle and curving around the greater trochanter. The trochanter is tricky; it's an important landmark at the side of the hips, but is basically invisible on muscular people unless they stand in *contrapposto* (page 130). Note the S-curve described by the leg when viewed from the side. It's also important to get the calves going into the thigh behind the knee.

10: Shaping the head

The skull can be visualized as a boxy egg laid on its side, with the face hanging off of the pointy side. It's important to put in the neck as soon as possible, as it helps inform the rest of the head structure. It sits at an angle to the skull, with the two distinctive rods of the sternocleidomastoid striking through in the opposite diagonal. As for the face, put in front and side planes and a hint of the jaw. The male jaw is generally more angular and the plane changes more severe than on a female face.

▲ Regardless of whether you start sculpting the head from a sphere or box, the basic process is the same



▲ From Robocop to the Silver Surfer, the face takes shape. The severe features will get softer with subsequent passes

11: Refining the head

The horizontal line indicates where the eyes should go. Notice how it's approximately in the middle of the face – a common error is to put the eyes too high. The eye sockets are carved in, about an eye's width apart. A hint of the cheekbone descends at a slight diagonal from the ear, which sits in the middle of the head when viewed from the side. The forehead also gets some attention, as it is actually a complex arrangement of planes. A few lines are carved in, setting up for further refinement. The mouth is sketched in, which completes the face.

12: Constructing the hand

Even though we turn our attention to the hand at this late stage, in practice a stand-in should be placed fairly soon, as it helps to understand the wrist and gauge the overall proportions.

A box makes sense given the shape of the palm. The edges are rounded and a proto-thumb is extruded. The male palm is generally squarish compared to the more elongated female hand. The palm's three fleshy pads are also sketched in at this stage. You can cheat slightly with the fingers, building one and then copying it across. Take care not to make the hand too small – another common mistake.

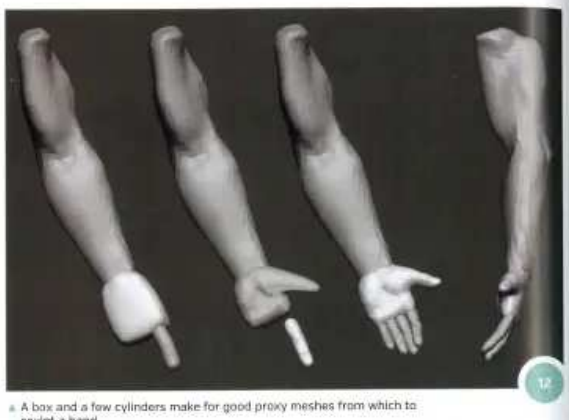
> "Even though fingers are assumed to be round in profile, they actually have surprisingly defined planes, so the resulting cylinder needs to have its roundness shaved off"

13: A closer look at the fingers

If you're using ZBrush, ZSpheres are an excellent way to quickly place a finger. Even though fingers are assumed to be round in profile, they actually have surprisingly defined planes, so the resulting cylinder needs to have its roundness shaved off. Once the fatty pads and knuckles are roughly carved in, we can duplicate the finger three more times. Then we size each finger in turn and modify it slightly to lose the uniformity. One important aspect to note is that fingers are not straight – factoring in their crookedness is actually what gives life to a sculpt.

14: Sculpting the feet

Finally it's time to add feet, making our model complete. As with the hands, in practice this should be done fairly early so as to better judge the proportions of the whole leg. A simple box will serve nicely, which can then be chopped up to suggest the slope of the foot.



▲ A box and a few cylinders make for good proxy meshes from which to sculpt a hand

▲ Another common beginner mistake is to make the fingers too straight. Bend those cylinders, but stop short of giving the figure arthritis

We proceed to soften the forms, adding the arch behind the big toe and sketching in the mass of the other toes. Low mesh density will force us to keep things simple for now.

15: Refining the feet

Despite their superficially simple shape, feet are tough to get right. Tiny details can make all the difference. Once the resolution is upped slightly, we can add a bit of detail and refine the overall shape. Toes are sketched in and given the sharp downward angle at the first knuckle. This doesn't apply to the big toe, which points straight. On the outside of the foot, the extensor digitorum brevis is hinted at – one of the foot's few visible surface muscles. Finally, the small bump on the outside of the sole is added, where the bone of the pinky ends.

16: Head overview

A common error is to make the skull too round. Looking from both the front and the side, there are subtle but definite angle changes which must be taken into account if the head is to look natural.

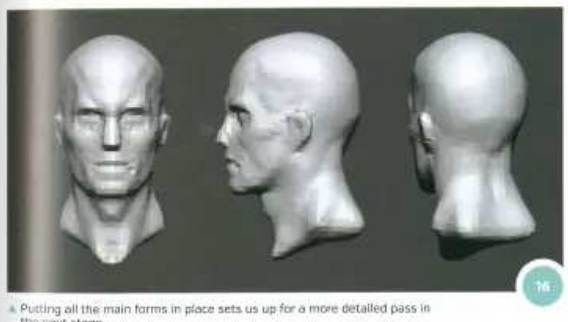
Another thing to note is the highest point of the skull, about two thirds of the way back, where it's also the widest. The temporal line marks the edges of the forehead. At the back, the distinctive little bump at the base of the skull is added in. One final thing to note is the Adam's apple (or laryngeal prominence), which is far more prominent in men.

> "A common error is to make the skull too round. Looking from both the front and the side, there are subtle but definite angle changes which must be taken into account if the head is to look natural"

17: Arm overview

Adding more resolution allows us to refine the landmarks and carve in lines where the muscles will go. In fact it's easy to go

▲ A lot of artists tend to avoid or rush the feet, but there's a real sense of accomplishment to getting them right



▲ Putting all the main forms in place sets us up for a more detailed pass in the next stage

The bone of the big toe [the first metatarsal] provides the main "rod" from which the rest of the foot forms.

▲ Fun fact: your foot is about as long as your forearm, but you likely aren't bendy enough to check!

▲ The upper arm appears far shorter than the forearm because much of its length is covered by the deltoid [shoulder]

overboard with the muscle definition as you're trying to find the forms and make them all fit. One helpful tip is to find the

ulna, which directly connects the elbow and one end of the wrist, ending in a distinctive bump [the styloid process]. All the other forms slot around it. Note that the ulna itself isn't entirely straight.

The upper arm is simpler, with just the bicep and triceps taking up the front and back, respectively.

"Our eye is trained to recognize the correct outline of the body, but without the masses properly flowing around one another, the end result will look wrong even if we can't say why"

18: Legs overview

The legs are an excellent example of the relationship between form and silhouette. Our eye is trained to recognize the correct outline of the body, but without the masses properly flowing around one another, the end result will look wrong even if we can't say why. Note how the outside silhouette of the leg is described first by the muscles at the front of the thigh, which are briefly taken over by the tendon attaching to the head of the fibula, only to transition into the calf muscles.

It takes all of these disparate forms, in different places, to come together to give us the correct silhouette.

19: Torso overview

Owing to the fairly advanced stage we've left the torso at, this second pass consists only of minor adjustments. All of the forms have been refined. The chest looks less sketchy, the rib cage has been softened, and even a bit of belly fat has been added.

On the back, the center line and the overly prominent scapulae have been smoothed out, while the two thick columns of muscle either side of the spine [the erector spinae] have been added.

A small bump at the base of the neck marks the location of the 7th cervical vertebrae, an important landmark.

20: Full body overview

It's a good idea to check the proportions again. Since the sculpt is still in parts, scaling or moving limbs is easy. In this case, the arms turn out to be a bit too long and the knees need shifting as well. The head is too big, so I scale it down to fit the heroic "8 heads" ideal.

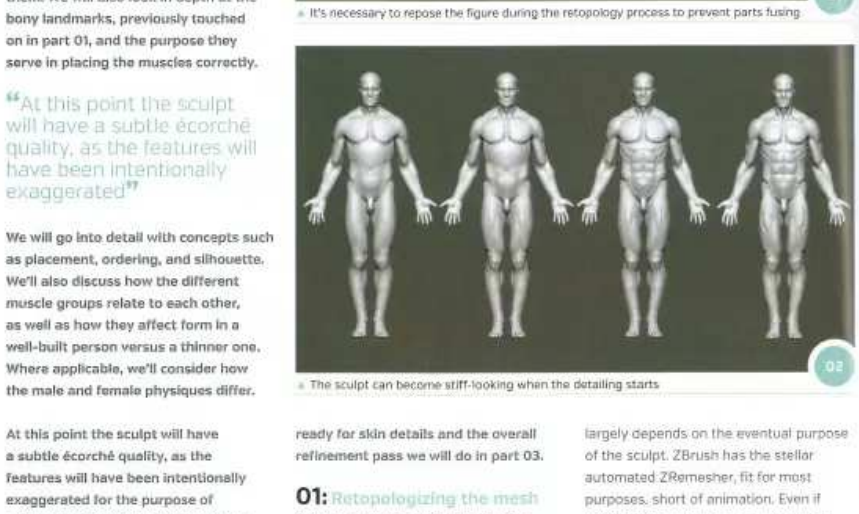
After making these adjustments, the first stage of sculpting is now complete.

PRO TIP

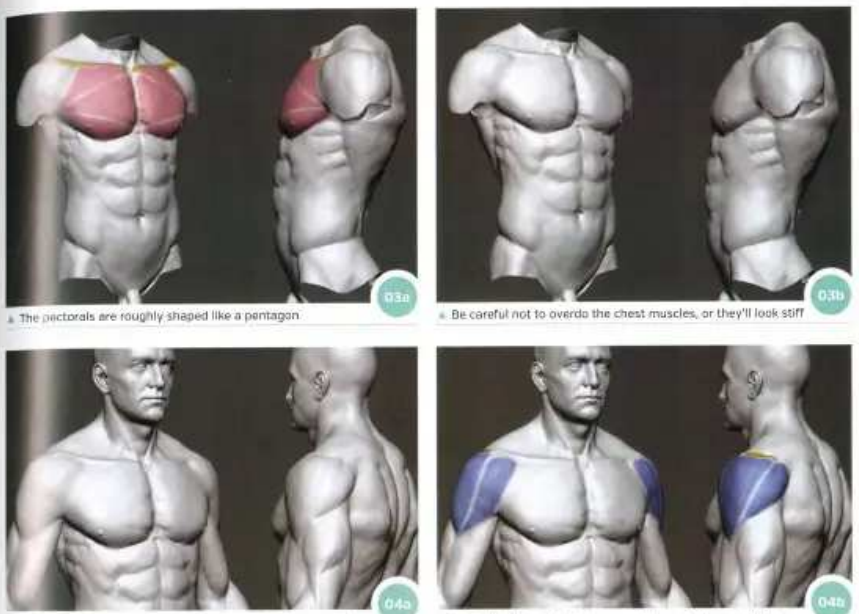
Try to add dynamism to your T-pose

Giving dynamism to a symmetrical T-pose is difficult, so it's vital to capture the rhythms inherent in the forms of the body.

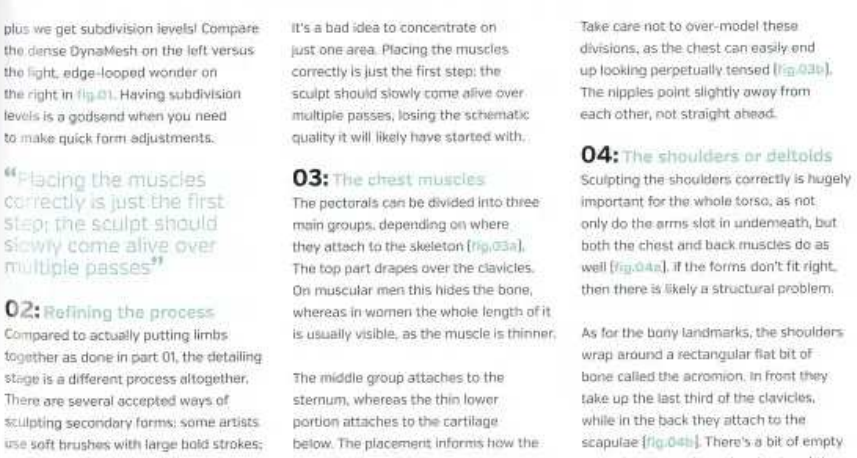
Be on the lookout for these and you'll have a better chance of avoiding the dreaded stiffness which can ruin otherwise anatomically perfect sculpts.



▲ The leg muscles are barely sketched in at this stage, with only a few lines put in for future reference



▲ Although the "dimples of Venus" above the buttocks are generally associated with women, fit men also tend to have them



▲ With all the forms in place and flowing nicely, the first stage of sculpting is now complete

Sculpting an archetypal figure

3D male

Part 02 | Muscles

By Djordje Nagulov

Freelance modeler

This second of three parts is focused on sculpting an anatomically correct male figure in a relaxed T-pose. At the end of part 01, we had built a solid base mesh, aiming to achieve good form, gesture and silhouette. This part will largely deal with the muscles.

Having only built up rough masses in the previous chapter, we will now turn our attention to all the main muscle groups that make up the human body. We will go over each muscle group in turn, pointing out important details and how they relate to the shapes around them. We will also look in depth at the bony landmarks, previously touched on in part 01, and the purpose they serve in placing the muscles correctly.

"At this point the sculpt will have a subtle écorché quality, as the features will have been intentionally exaggerated"

We will go into detail with concepts such as placement, ordering, and silhouette. We'll also discuss how the different muscle groups relate to each other, as well as how they affect form in a well-built person versus a thinner one. Where applicable, we'll consider how the male and female physiques differ.

At this point the sculpt will have a subtle écorché quality, as the features will have been intentionally exaggerated for the purpose of instruction. However, this should put

▲ It's necessary to repose the figure during the retopology process to prevent parts fusing

▲ The sculpt can become stiff-looking when the detailing starts

ready for skin details and the overall refinement pass we will do in part 03.

01: Retopologizing the mesh

Before detailing starts, it might be a largely depends on the eventual purpose of the sculpt. ZBrush has the stellar automated ZRemesher, fit for most purposes, short of animation. Even if we won't be animating or unwrapping

▲ The pectorals are roughly shaped like a pentagon

▲ Be careful not to overdo the chest muscles, or they'll look stiff

▲ Getting the shoulders right is essential not just for a realistic torso, but for attaching the arms correctly

▲ The deltoids attach to the scapulae by a tendon, which is why it looks flatter by the bone

plus we get subdivision levels! Compare the dense DynaMesh on the left versus the light, edge-looped wonder on the right in fig.01. Having subdivision levels is a godsend when you need to make quick form adjustments.

"Placing the muscles correctly is just the first step; the sculpt should slowly come alive over multiple passes"

02: Refining the process

Compared to actually putting limbs together as done in part 01, the detailing stage is a different process altogether. There are several accepted ways of sculpting secondary forms; some artists use soft brushes with large bold strokes; others feel cross-hatching with quick it's a bad idea to concentrate on just one area. Placing the muscles correctly is just the first step; the sculpt should slowly come alive over multiple passes, losing the schematic quality it will likely have started with.

03: The chest muscles

The pectorals can be divided into three main groups, depending on where they attach to the skeleton (fig.03a). The top part drapes over the clavicles. On muscular men this hides the bone, whereas in women the whole length of it is usually visible, as the muscle is thinner.

The middle group attaches to the sternum, whereas the thin lower portion attaches to the cartilage below. The placement informs how the masses shift when the arm is raised. Take care not to over-model these divisions, as the chest can easily end up looking perpetually tensed (fig.03b). The nipples point slightly away from each other, not straight ahead.

04: The shoulders or deltoids

Sculpting the shoulders correctly is hugely important for the whole torso, as not only do the arms slot in underneath, but both the chest and back muscles do as well (fig.04a). If the forms don't fit right, then there is likely a structural problem.

As for the bony landmarks, the shoulders wrap around a rectangular flat bit of bone called the acromion. In front they take up the last third of the clavicles, while in the back they attach to the scapulae (fig.04b). There's a bit of empty space between where the chest and the

us in a good position moving forward, with most of the forms locked in and

good idea to retopologize your model. This step isn't necessary per se, and

UVs, retopologizing benefits us in other ways – I have stitched on some toes.

strokes offers more control. In either case, the model is worked over as a whole.

All three converge underneath the armpit, twisting like a wet towel.

shoulder meet. This creates the distinctive triangular hollow at the clavicle.

05: The neck

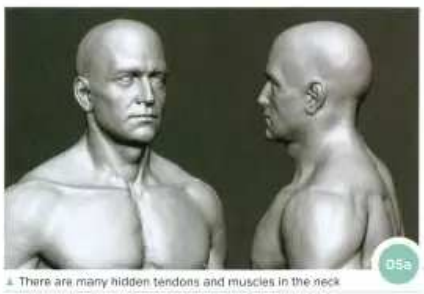
The neck has a lot going on under the surface, but most of these forms are invisible at rest.

The most distinctive feature of the neck, apart from the Adam's apple (or laryngeal prominence) in men, is the diagonal column of the sternocleidomastoid muscle (fig.05a). While this muscle attaches to one place on the skull (behind the ear) it branches into two strands at the base. One offshoot attaches to the clavicle; the main strand turns in to a tendon and actually plunges into the dimple in between the clavicles (not at the clavicular ends, as is often assumed). The trapezius completes the back portion (fig.05b).

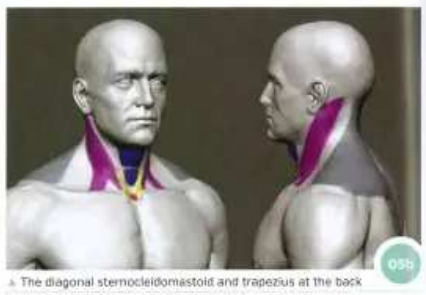
"The neck has a lot going on under the surface, but most of these forms are invisible at rest"

06: The abdominal muscles

The abdomen is probably the first place we should break symmetry as soon as possible – the separate squares of the "six-pack" are surprisingly misaligned in a lot of people (fig.06a). They can also vary in shape dramatically. For example in some people the horizontal divisions appear parallel, while in others they may spread out like rays. Using a lot of references for this stage is therefore a good idea.

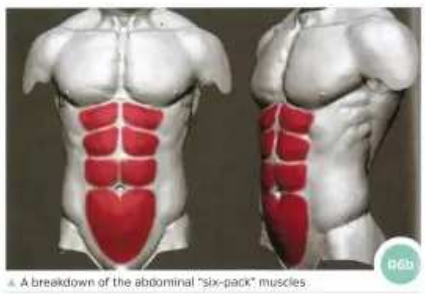


▲ There are many hidden tendons and muscles in the neck



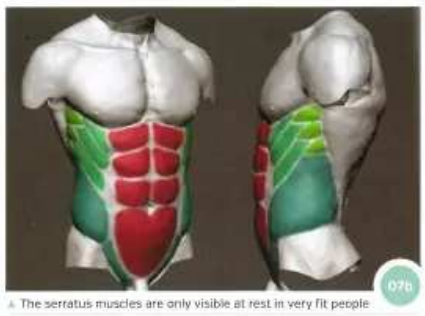
▲ The diagonal sternocleidomastoid and trapezius at the back

▲ The sculpt will need some toning down in the next part

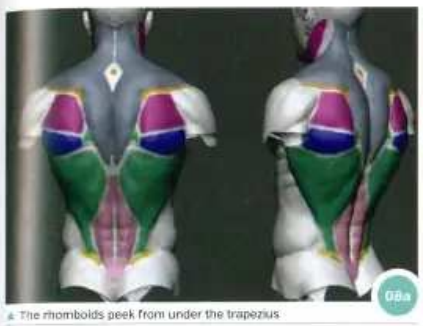


▲ A breakdown of the abdominal "six-pack" muscles

▲ The rib cage is now mostly hidden beneath groups of muscles



▲ The serratus muscles are only visible at rest in very fit people



▲ The rhomboids peek from under the trapezius

▲ Most back muscles anchor to the scapulae and iliac crest

▲ The large quadriceps muscles give shape to the thigh

▲ The iliotibial band gives extra forms to the side of the thigh

▲ Most of the hamstring muscles on the back of the thigh can be sculpted as one larger mass

▲ Even a super-fit physique has fat on the gluteal muscles, so make sure you add some to achieve a realistic looking sculpt

10: The back of the thigh

The back of the thigh is much simpler to sculpt. The hamstrings emerge from under the gluteal muscles and attach to either side of the knee (fig.10a). Although they're actually in two main groups, they form a unified mass in the majority of people, so be careful not to over-define them.

It's a similar situation on the inside of the thigh, where a fair number of muscles are located but can generally be sculpted as one mass. The gluteus wraps around the greater trochanter. There is a break in the form on the side, but due to fat the shapes are generally softer here (fig.10b).

11: Construction of the knee

The knee is a complex composite area where several muscles and tendons flow through. Much of it is composed of bone, especially in the front. Most prominent of which is the triangular shape of the patella, which sits above the thick plateau of the tibia. To either side of the patella, the lumpy ends of the femur and tibia can be discerned, while on the outside the bump of the fibula provides another useful landmark (fig.11a).

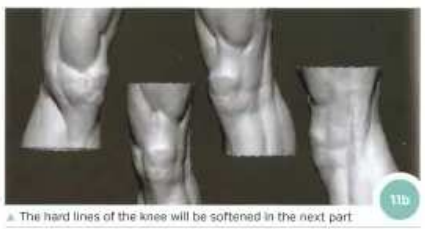
All of these shapes need to be taken into account in order to sculpt the knee correctly, as well as knowing how they shift when the knee bends (fig.11b).

12: Calf muscles

The calves are made up of many long, thin muscles, much like the forearms (fig.12a). The tibialis anterior is the most important of these on the front, as it starts on the outside of the knee and wraps around the tibia to end up on the opposite side at the ankle. Notice that from the side, it takes over the silhouette, rather than the bone as might be assumed (fig.12b).

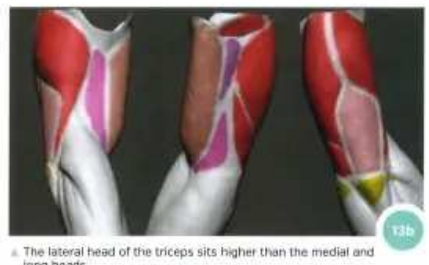
The gastrocnemius muscles in the back give the calves their signature shape. It's important to note that the outside portion sits higher than the inner one. It's the opposite situation with the ankles, the inside pair being higher.

▲ Remember to keep the bony landmarks of the knee well defined



▲ The hard lines of the knee will be softened in the next part

▲ The biceps are fairly straight when looked at from the side but curve slightly towards the end



▲ The lateral head of the triceps sits higher than the medial and long heads

▲ The forearm's muscle details are subtle but complex

▲ It takes considerable practice to place muscles correctly

13: Muscles of the upper arm

The biceps are nestled on the brachialis, which peeks out to either side (distinct only on really muscular people). Viewed from the side, the biceps are actually fairly straight, only curving towards the end (fig.13a). It's surprising to consider how much of the whole area is taken up by the triceps – the lateral head on the outside has the distinctive comma shape, while on the inside the medial and long heads tend to merge into one mass (fig.13b). All three heads attach to a large tendon which flows directly into the triangular middle bump of the elbow – the olecranon.

14: Muscles of the forearm

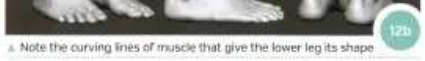
Like the lower leg, the muscles of the forearm are tough to analyze correctly (fig.14a). It helps to break them down into three main components: the extensors on the outside, the flexors on the inside, and the brachioradialis, which provides the distinctive shape as it wraps the silhouette: the muscles of the thumb which "interrupt" the extensors, and the elongated triangle of the anconeus, which sits under the olecranon (fig.14b). In well-developed forearms, the ulna is basically a furrow, much like the scapulae.

15: Shaping the hands

Placing and sizing the thumb correctly can be tough. It's angled at about 40 degrees relative to the rest of the hand, and the first knuckle should just about meet the bottom joint of the index finger. There aren't many muscles to speak of, save for the few which give the palm its two bottom pads. Elsewhere it's mostly bone, tendons, and fat pads.

When the hand is at rest, try not to exaggerate the tendons. Keep in mind that the tips and knuckles of the fingers describe arcs, rather than being parallel. Looked at from the front, the hand itself has a slight curve.

▲ The long, thin muscles and bony landmarks of the lower leg



▲ Note the curving lines of muscle that give the lower leg its shape

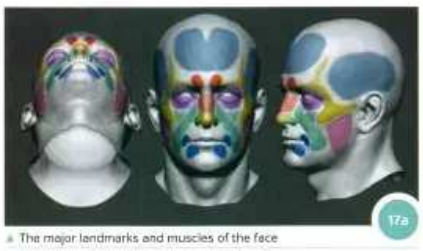
around the radius. Note how far into the upper arm it climbs. Two other, easily overlooked shapes are also crucial for

▲ You can use your own hand for detailed references

16: Shaping the foot

When detailing the foot, take care to give enough curvature to the toes. The smallest toe should smoothly flow into the sole, with almost no angle change. The three middle toes basically share the same appearance, varying only in size; the second toe is often the longest, although this can vary. As with the hands, the forms of the foot are mostly derived from bones, tendons, and fat pads. The largest form is the heel, which tapers into the thick Achilles tendon. One other notable tendon comes from the tibialis anterior at the front, crossing diagonally as it travels across the ankle.

▲ A wet footprint can help you visualize which parts of the foot touch the ground



▲ The major landmarks and muscles of the face

▲ Don't overdo the cheekbones, or you'll have a gaunt face!

▲ The face has many soft, fleshy areas that need a subtle hand to capture

▲ The nose is harder to sculpt than it seems; you need to understand the subtler forms for a good sculpt

17: Main head shapes

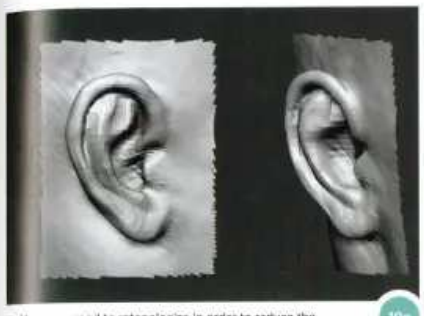
Fitting the face together can be difficult. Knowing relative sizes can be a big help: the nose takes up about a third of the face vertically; the lips are about as wide as the centers of the eyes; the ears extend from the corner of the eye to the bottom of the nose, and so on.

One other tip is to look at the sculpt from below, checking for adequate curvature in the forehead and whether the lips wrap correctly around the teeth. Notice how the jaw line is actually fairly soft; a common error is to make the jaw too prominent or angular [fig.17a, fig.17b].

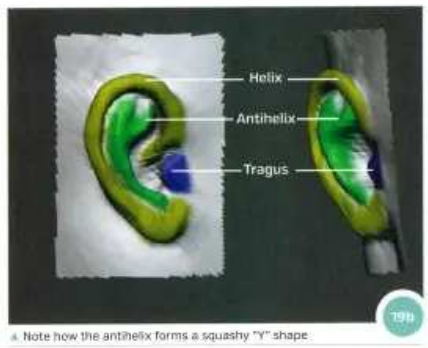
18: Structures of the face

When sculpting the face, it's important to know where soft tissues take over from bone [fig.18a]. Shapes vary greatly with age, but the positioning remains the same. The brow area is generally more rugged in men, with a prominent glabella [the skin between the eyebrows], and the eyes are set deeper and closer to the brow.

The mouth has two prominent nodules at the corners and under the bottom lip. Take care to make the mouth feel properly fleshy instead of carved in. The philtrum [the groove between the nose and lips] is usually longer in men. Transitioning it into the nose can be a tricky area to get right [fig.18b].



▲ You may need to retopologize in order to reduce the mesh density



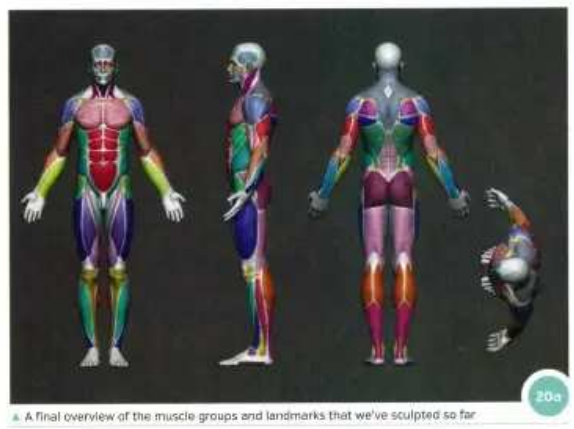
▲ Note how the antihelix forms a squashy "Y" shape

19: Constructing the ear

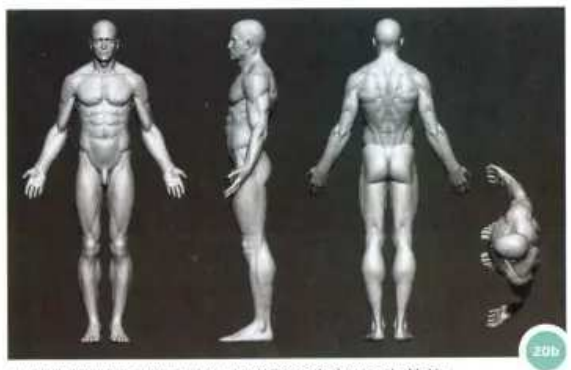
The ear can seem daunting at first, but putting the shapes together is fairly easy once you mentally separate them. The mesh density may need reducing because the ear is quite a detailed part of the model [fig.19a]. The large spiral of the helix describes the whole ear and flows into the center concavity. The antihelix sticks close to the helix and takes up most of the inside, looking like a curved "Y" [fig.19b]. They end at the fleshy lobule on the bottom. The tragus is a small plate of cartilage that covers the ear hole. A lot of people have a bump on the upper third of the helix, which tends to give ears more character.

20: Full body overview

After a lot of carving, nudging, and cross-hatching, we now have all the muscles sculpted and positioned correctly. Hopefully this didn't require major restructuring, as we covered the roundwork in part 01. Proportions were checked and adjusted to reference, as they tend to drift as work progresses [fig.20a]. The sculpt is now in a strange half-state between realistic depiction and écorché treatment. The muscle groups are all a bit exaggerated and the body mostly lacks skin and fat. The next stage will aim to soften transitions and give a more natural feel to the sculpt [fig.20b].



▲ A final overview of the muscle groups and landmarks that we've sculpted so far



▲ With all the muscle groups in place, we can finesse the forms and add skin (in part 03)

Sculpting an archetypal figure

3D male

Part 03 | Skin

By Djordje Nagulov

Freelance modeler

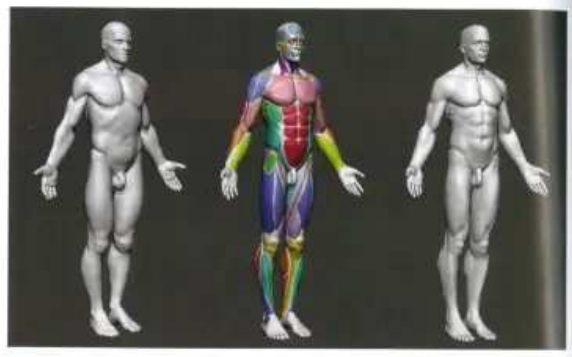
Having covered base mesh creation and muscle sculpting in previous parts, the time has come to finalize the model with a few more refinement passes.

Even though our sculpt has jumped a few orders of magnitude in complexity over the course of part 02, at this point it's still looking fairly stiff. Our main purpose in this installment will be to rectify the raw, schematic quality of the naked muscles which, although correctly placed, still look far from natural. We will aim to achieve this by overlaying skin, softening forms, putting wrinkles and folds where appropriate, and introducing small fat pouches which fill out the body in various places. Here we'll also touch on fat distribution, as it relates to the differences between male and female forms.

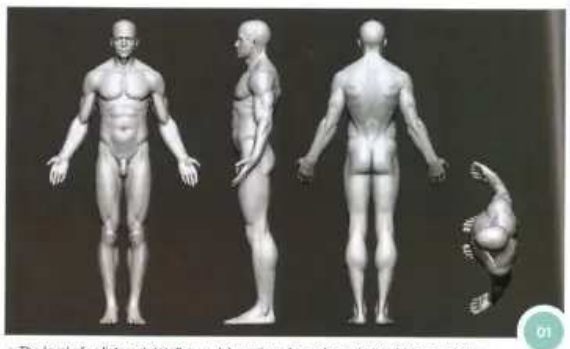
During this process we will discuss several important ways in which artists can imbue naturalism into their sculpts. Key concepts will include breaking symmetry, line weight, variance, and visibility. Once the refining stage is close to finished, we'll add a final layer of detail: veins and pores. We will then portray the final form under different lighting scenarios, which will help us read the shapes properly.

01: Surface treatment

Having used cross-hatching as our main method of sculpting, the surface of the model at this intermediate stage can be fairly rough. Each successive pass uses a finer intensity of brush,



▲ From base mesh to muscle groups to detailing, it can be a long journey before a sculpt starts looking good – perseverance is key



▲ The level of polish and detail a model requires depends on the project's purpose; we're aiming for a soft and naturalistic look here

This process can be continued until the surface looks almost burnished. Leaving the strokes still visible and the

setups, come render time. It all depends on what the model will be used for.

smooth out the surface. If the cross-hatching is already done to a fine enough level, this process can be trivial. Don't overdo the smoothing or you'll lose all the detail you've spent hours building.

Go over the model muscle by muscle, slowly removing brush marks and taking care not to erase sharp transitions where they belong [for example the creases on the fingers]. If an area is still too rough and results in an uneven surface, some kind of fill brush and a light touch will be necessary, but mind that the shapes don't become too uniformly smooth. Introducing a bit of unevenness in the forms can suggest subtle muscle striation and tissue distribution under the skin. It's these imperfections that can really sell a sculpt.

02: Sculpting skin

Apart from smoothing out the surface [and perhaps adding pores as a final step], simulating skin mostly comes down to adding fat and creases in key areas. For example, skin is relatively thick at both the elbow and knee when the limb is straight, obscuring the bony landmarks somewhat. These areas have an excess of skin which slides over the joint as it bends. In other places, such as the base of the back, skin is more tightly lashed to the tendinous sheet covering the erectors, which reveals extra detail in the form of subtle horizontal strokes.

▲ Alternating plain and detailed areas is key to a good sculpt. The arm naturally has areas of permanent wrinkle detail, especially around the elbow

▲ Here we aim to add realistic fat without losing all the muscle detail

Skin with a healthy amount of body fat tends to hide most of the muscles we've spent so much time shaping correctly. The middle quadriceps muscle at the front of the thigh is invisible in most people when they're not tensing the leg. The triceps, which artists like to sculpt the heck out of, look like one large mass at rest, with only the slightest shading to suggest the distinct comma shape of the short head attaching to the tendon. The abdomen is another area where over-sculpting is especially common and can result in ugly, tense-looking models. Softening that area properly without losing the six-pack detail can be tricky [fig.02a].

Other places which help sell the illusion of skin are the creases where the limbs attach to the torso, as well as the large, permanent wrinkles at the elbow [fig.02b], back of the knee, and inside of the wrist. The creasing at the armpit and groin is usually fairly subtle, but important. The large wrinkles don't need to be overly detailed. In fact, our final mesh density of around four million polygons doesn't really have enough resolution for close-ups, but should be good enough for viewing at middle- to near-distance.

03: Wrinkles and fine weight

When it comes to fine details such as wrinkles and creases [fig.03a], an artist can either use alphas or draw them by

not unlike using different grades of sandpaper to smooth out the forms.

resulting graininess can give the sculpt a lot of character under different lighting

For our purpose we'll assume the natural feel of skin is required, so we need to

▲ Pay attention to how the wrinkles look on the fingers, both inside and outside. Make sure you capture the numerous folds at the thumb

hand. Using alphas has many benefits, not the least of which is the built-in

natural feel of the surface they were sourced from. On the flip side, our eye is good at picking up repetition, so you have to be careful not to overuse the same few textures. It's generally a good idea to go over an area already detailed by alphas and put in individual touches to break up any obvious patterns.

If you're doing wrinkles entirely by hand, there are a few pitfalls to watch out for. One is our tendency to draw parallel lines – nature abhors parallel lines! If you look carefully, there's hardly a single line in the human body that runs perfectly straight for any great length, let alone parallel to another line. There are always curves, angles, and plane changes [fig.03b]. Wrinkles in particular are often composed out of several broken-up segments. Equally spaced creases are another common mistake, which in part occur because it's easy to forget (or be lazy about) changing a brush's size and intensity.

Line weight is another hugely important concept which can make a big difference in the final look of our sculpt. One of the reasons our model looked fairly stiff at the end of part 02 was the uniformity of detail – every shape received equal attention, every muscle was delineated clearly. In reality, of course, clarity varies greatly, even in the same area. Some strokes start deep but turn shallow as they go. Other shapes can look hard in one place and soft in another (the knee is a great example of this). Variety is key. Take care to avoid making too many strokes with the same depth and size as this can very quickly suck the vitality out of your sculpt.

▲ Don't make the mistake of using parallel lines to describe the human body – there aren't any! Instead, think in S-shapes and contrasting curves, such as in the legs

▲ Fat is generally far less prominent in men than women, though fitness and lifestyle have a big influence

04: Fat distribution

Fat has less of a role in describing forms on a fit male than it does on female bodies. Even fit women tend to have fat on the sides of the thighs, buttocks, and over the obliques, which smoothes out the silhouette and helps give the figure its signature hourglass shape. In men it's mostly just muscles, at least until age and lifestyle forge a belly and the euphemistic "love handles" over the hips. Having said that, there are a few places where strategically adding fat pouches helps give a male sculpt a more natural feel.

First and foremost are the gluteal muscles. At extreme, near-lethal levels of fitness, bodybuilders will try to remove every last ounce of fat from their bodies. While this reveals the true shape of the muscle and the way it attaches to the femur, it looks unnatural to most eyes. When sculpting the buttocks, be mindful not to be overzealous with your anatomy knowledge and neglect adding enough roundness.

One other place where it makes sense to add a bit of fat is the knee. As we saw in part 02, the knee is a complex area with a lot of bony landmarks. Most of these protuberances are actually made rather subtle due to thicker skin and pouches of fat. The area above the patella, especially, tends to have an overhang of fatty tissue which covers the tendon and obscures detail.

05: Pores and veins

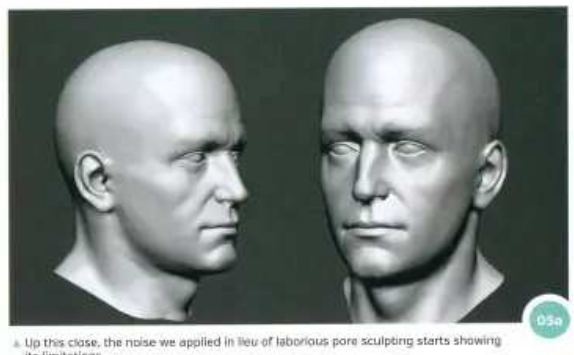
After spending time smoothing out the surface, in the end we rough it up again by adding pores. This doesn't have to be a laborious process – a simple overlay of procedural noise will add just enough tiny pockmarks to break up the specular highlights. If your software supports it, it's a good idea to put these into a separate layer, as it may be necessary to adjust their intensity once it's time to render the model. The primary aim of this step is to prevent the surface texture from seeming like smooth plastic.

> "Veins are generally more pronounced in men. They're primarily visible in the forearms, hands, and feet, where they are close to the surface and the skin is fairly thin"

Note that this approach only gives us a "quick 'n' dirty" version of what can be a fairly involved undertaking. This is especially true for the face, where the uniformity of procedural noise doesn't hold up to scrutiny once we zoom in close [fig.05a]. If we were making a realistic bust, a whole new level of surface fidelity would be required, but for our purposes, this should be good enough to make a few test renders with a nice granularity to them.

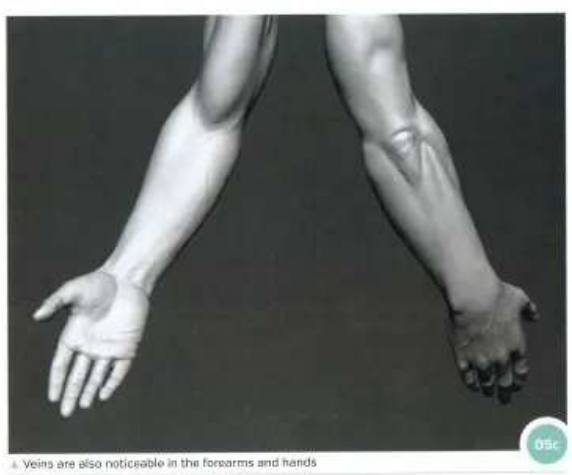
Veins are generally more pronounced in men. They're primarily visible in the forearms, hands, and feet, where they are close to the surface and the skin is fairly thin [fig.05b, fig.05c]. It can be tricky to gauge what thickness veins should be and how obvious to make them.

Sculpting veins on a smooth surface can be a jarring, so use layers to control intensity and don't forget to vary your brush size. Reference is key, but useful photos are surprisingly hard to find, as extremely fit people tend to have overly pronounced veins (vascularity) while more average people have nearly none. However, this confusion about placement and complexity can be freeing – it allows you to make up the veins up to a point, as long you remain in the ballpark of realism (but don't tell anyone we said that)!



▲ Up this close, the noise we applied in lieu of laborious pore sculpting starts showing its limitations

▲ Veins are prominent in the hands and feet, where they're close to the surface and the skin is thin



▲ Veins are also noticeable in the forearms and hands

06: Breaking symmetry

Automatic symmetry is one of the huge benefits that digital sculpting provides over real-world clay modeling. Only the truly disciplined can summon the will to sculpt everything twice when

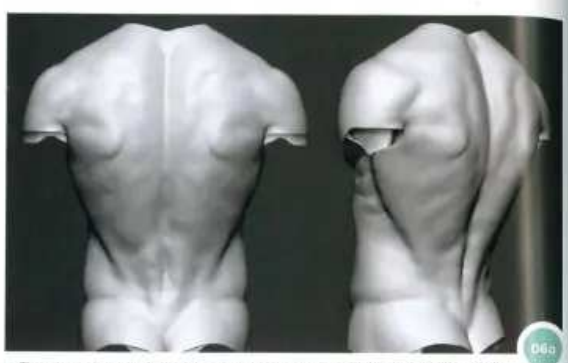
such a shortcut is available – although I personally encourage artists to sculpt dynamic poses when they can, because it forces you to juggle both sides.

Once a sculpt reaches a certain point, however, it becomes imperative to break up the symmetry. Our eye is very good at noticing when something looks wrong, and shapes mirroring perfectly across the center line practically scream "digital sculpt!" [fig.06a]. This will likely offend your own artistic sense, so now is a good time to start introducing variation.

The abdominal "six-pack" muscles should be individual; varying the striation of the chest is also a good idea [fig.06b]. How far away from the center line you sculpt unique detail depends on many factors, but you need to make sure the model loses the mirror-image effect. The back should receive similar treatment.

Asymmetry is also crucial in the face – in fact, most people have surprisingly uneven faces. The effect is subtle, but powerful – a perfectly symmetrical face looks vaguely robotic, but introducing slight variations here and there will give it life, even though both halves still appear the same.

As with the veins and pores, it's a good idea to put these changes on a separate layer, so that you still have access to symmetry should re-sculpting be necessary.



▲ The schematic appearance of the back muscles has been smoothed away. Note how the outline of the scapulae varies in intensity – uniformity looks artificial

▲ Once you start sculpting the symmetry away, it can be tricky to go back to it unless you make the changes on a separate layer

▲ Moving the light source around while sculpting can help evaluate the shapes better and reveal forms in a new light (sorry for the pun)!

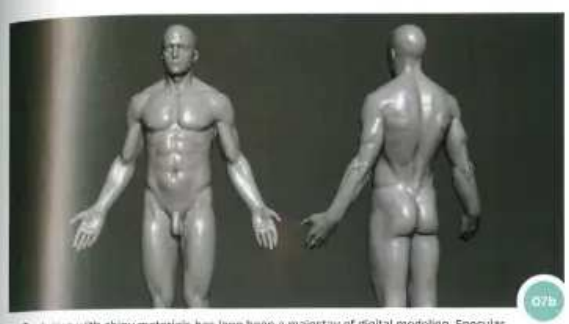
07: Checking forms with light

One advantage traditional sculpting has over digital is that changing the direction and intensity of light is trivial. Just the day passing will provide you with a constantly shifting lighting setup which helps to read the shapes correctly. In a digital environment, a lot of beginner artists tend to sculpt all the way through with a single light setup. This is mostly adequate, but there are pitfalls to watch out for.

An unchanging environment does not

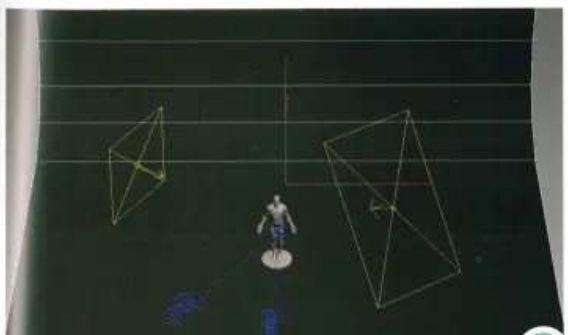
until rendering with a different setup suddenly reveals them [fig.07a].

to move the light source around, it's sometimes easier to power through



▲ Sculpting with shiny materials has long been a mainstay of digital modeling. Specular highlights help you to read the forms properly but can exaggerate intensity of detail

▲ When rendering, expect to return to your sculpting software in order to tweak the many small mistakes which will suddenly jump out at you



to a different environment, again, the mistakes will show. It's therefore a good idea, if possible, to adjust the user interface so that moving lights around becomes a part of your workflow.

Another makeshift solution is to simply change the material properties of the mesh [fig.07b]. For example, ZBrush has MatCaps (materials with baked-in light and reflection) which can do wonders for assessing the sculpt with fresh eyes. If you don't have MatCaps, it can even be helpful just to dial in some specularity, because shiny surfaces read a lot better than dull ones.

08: Final proportions check and rendering

Before I send my model over to 3ds Max for rendering, proportions are checked one final time. It turns out the forearms are a bit too long and I need to scale up the hands slightly.

PROTIP
Refresh your eyes

If at all possible, try to give yourself some time away from the sculpt before you do your final check. That way you'll be more likely to catch overlooked flaws with rested eyes.

Effective presentation can elevate your hard work from merely "good" to "great" [fig.08a]. Setting up a solid render doesn't have to be complicated. Once I've decimated the sculpt to a more manageable 1.2 million, I import it into 3ds Max and quickly build a scene with just two lights: a main light and a stronger rim light on the opposite side to achieve those sweet highlights. A simple dark background with no sharp edges completes the "studio" [fig.08b].

A fair amount of tweaking and re-rendering will inevitably be required, but a pleasing render should

always provide enough information about your model's forms. Flaws can remain undetected for a long time,

Another problem can manifest if there's too much friction with your interface – if it's too disruptive for your "flow"

with less-than-ideal lighting which doesn't show your shapes or sculpting properly. Once you move your model

You can get really fancy when rendering, with HDR backgrounds and whatnot – or you can have two area lights and a background sheet

emerge eventually. You can save this scene for future use in order to cut down on rendering time.

Sculpting an archetypal figure

Advanced 3D male

Part 01 | Head, neck, and face

By Djordje Nagulov

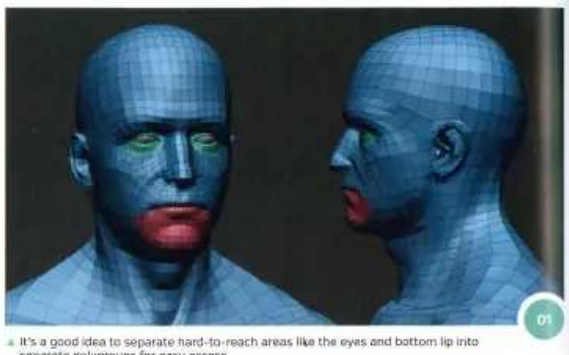
Freelance modeler

Over the course of the previous chapter, we built a full sculpt of an idealized male in a relaxed T-pose from scratch. In this next four-part chapter, we'll take a look at several areas of the human body in more detail by placing the figure in different poses and examining how the forms move. First in this part, we'll explore the features of the neck and face.

As we'll be sculpting several extreme expressions in order to analyze how the shapes of the face interact, retopologizing the head and neck will be necessary to begin with. Here we'll briefly touch upon good working practices and the many benefits of proper edge flow.

Once this is complete, we will proceed to rotate the head in several different directions, so that we can study how the neck muscles and tendons appear at the extremes of rotation. We'll also pay attention to how skin bunches and folds as the neck moves.

After the neck we'll take a look at the main facial features. The mouth and eye area in particular will go through several different expressions to showcase how mobile the human face is. This will allow us to inspect how the main masses on the face shift and in which direction. Some of the key concepts we'll go over include: respecting volumes, wrinkle direction, and bone versus tissue visibility. The nose will also get some attention, as its influence on achieving a natural-looking expression should not be overlooked.



01

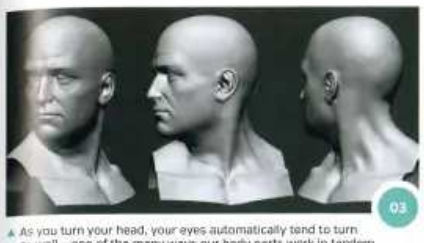
It's a good idea to separate hard-to-reach areas like the eyes and bottom lip into separate polygroups for easy access

02

Wrinkle depth and density give a face character, but can also pile on the years. Pay attention to their direction, especially around the eyes

01: Retopologizing the head and neck

The automated retopology used previously was adequate for a neutral expression, but now that we need to sculpt several dynamic expressions, manual retopologizing is necessary. This will save us a lot of time in the long run – introducing proper edge flow around the mouth and eyes greatly facilitates shifting the shapes around, as the underlying geometry won't stretch too much or run diagonally to your strokes. I've also created a mouth cavity. Try to



03

As you turn your head, your eyes automatically tend to turn as well – one of the many ways our body parts work in tandem

04

The portion of the trapezius attaching to the base of the skull practically disappears behind bunched skin when we look up

put the "stars" (vertices where five or more edges converge) in places where deformations aren't too extreme, as they can cause pinching on the surface.

02: The face at rest

Once the retopology process in 3ds Max is done, we can import the mesh back into ZBrush and transfer over most of the detail from the original sculpt. The wrinkles are rebuilt on a separate layer (taking care to make them asymmetrical), as this allows us to fine-tune their visibility.

Proper eyeballs are placed into the eye sockets as separate objects, and the upper eyelid now folds properly under the brow. Be sure to make the eyelids fairly thick, so that the inside edge of the lower eyelid catches the light enough to make a pleasing arc.

03: Turning the head

Mask off the neck with a soft falloff at a low subdivision level. Try to find the best place for head rotation, near the base of the skull, right under the ears. No matter how precise you try to be, the neck will likely end up looking like a twisted candy wrapper. Make sure you regain proper volumes by inflating the collapsed areas. The sternocleidomastoid muscle is very prominent in this pose, nearly vertical and popping out of the neck. As the head turns, other muscles that run under it reveal themselves. On the opposite side it is invisible, hidden by multiple skin folds.

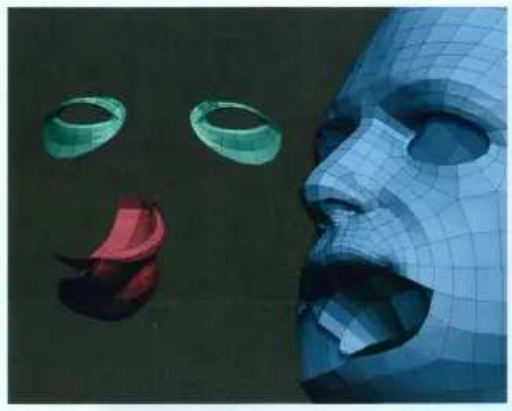
04: Looking up

Since we know where the main muscles in the neck attach from previous articles, tilting the head up is a relatively simple, connect-the-dots affair. As the sternocleidomastoid muscles stretch, the other main strand attaching to the clavicles becomes faintly visible. The muscles themselves tend to bulge out slightly when viewed from the front as they compress softly against the trapezius. The skin at the front of the neck stretches fairly thin and becomes almost vertical when the head tilts to the extreme. The laryngeal prominence (Adam's apple) becomes more noticeable as a result. When viewed from the back, only a few folds of skin show between the skull and the trapezius.

PRO TIP

Polygrouping to victory!

ZBrush has a neat feature called polygrouping, which allows the user to quickly create differently colored selection sets. These groups let us easily isolate or mask different parts of the mesh we want to work on, but their true usefulness comes to the fore when dealing with difficult-to-reach areas such as the inside of the mouth or the folds of the eyelids. Creating polygroups works best at the lowest subdivision level since you're dealing with the least amount of polygons. Extra tip: use Ctrl+Shift+S and Ctrl+Shift+X to grow/shrink polygon visibility, and Ctrl+W when you're happy with the selection to make a polygroup.



We've touched on polygroups before, when discussing how to access areas such as the armpit or the groin

"The whole upper portion of the head is largely defined by the shapes of the skull, even in corpulent people"

05: Looking down

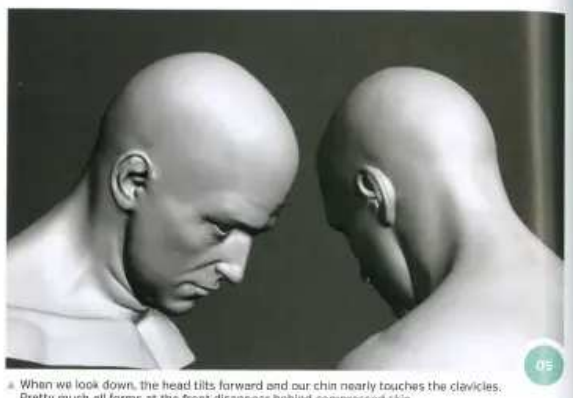
It's a similar situation when the head tilts in the opposite direction, with the roles reversed. The trapezius stretches between the shoulders and the skull, becoming quite taut as it flattens against the vertebrae. This pose also reveals the angle change that happens at the base of the neck as the bony landmark of the C7 vertebrae sticks out. The columns of the sternocleidomastoid muscles shorten considerably, and their bottom halves hide in the folds of skin that form at the front of the neck. All that extra skin under the chin compresses into thick folds, in many cases obscuring the jaw line.

06: Bone visibility

As you may have noticed, the face doesn't have that many muscles that describe forms. In fact, the whole upper portion of the head is largely defined by the shapes of the skull, even in corpulent people. In a neutral expression, we can usually see most of the ocular orbit and the outside parts of the cheekbones. Once we start introducing other expressions and the shapes shift, it's important to keep in mind where the bone is. Since a lot of soft tissue on the face is rather thin, bone structure will in most cases be fairly visible – and more importantly, immovable.

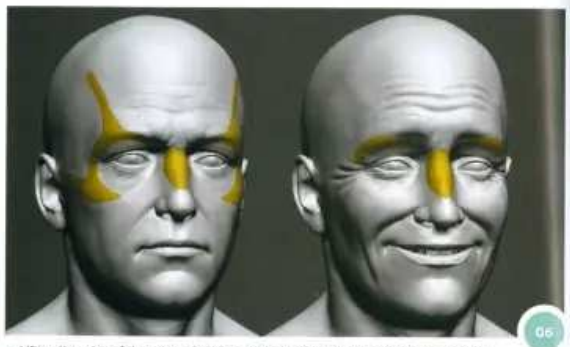
07: Muscle direction and skin folds

The lower half of the face has many thin, stringy muscles which radiate away from the mouth and serve to move the lips. For our purposes we don't need to know their names, origins, and insertions. From a sculpting perspective, however, you need to keep in mind that the tension that results from these muscles drives a lot of primary mouth shapes, whereas the secondary, surface forms are actually formed by the skin



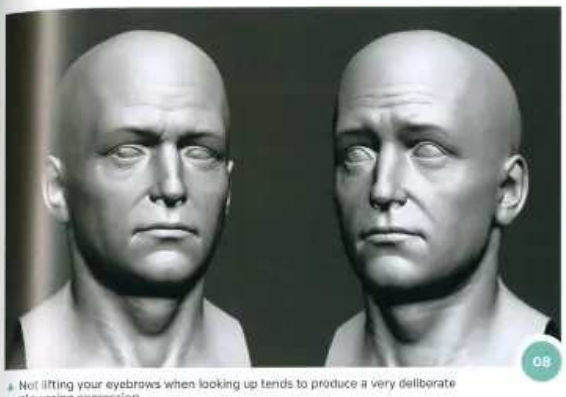
05

When we look down, the head tilts forward and our chin nearly touches the clavicles. Pretty much all forms at the front disappear behind compressed skin



06

Lifting the edge of the eye socket along with the eyebrows is a beginner's mistake. Bones of the skull don't move!



08

Not lifting your eyebrows when looking up tends to produce a very deliberate glowering expression

is the most distinctive of these, visually separating the mouth from the cheek.

"It's important to note that many movements on the face involve the surrounding features as well"

08: Rotating the eyes

The eyeballs are only slightly larger than the eyelids. Due to the bulge of the cornea, the eyeball isn't completely spherical. This influences the shape of the eye as we look around. When rotating from side to side, the cornea shifts the upper eyelid, making the eye ever so slightly larger where the pupil is and tapering off at the opposite corner.

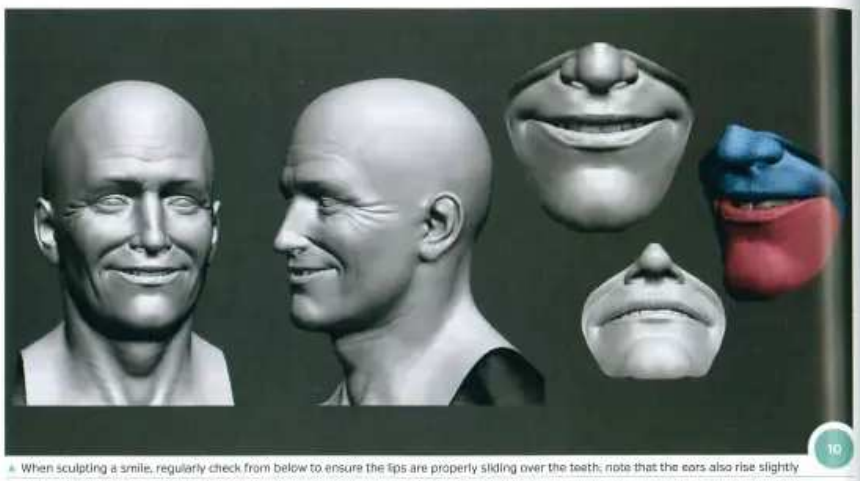
It's important to note that many movements on the face involve the surrounding features as well. When looking up, we tend to automatically lift the eyebrows, which is why you often get some wrinkling in the forehead.

09: Closing the eyes

The upper eyelid does the lion's share of the movement when we close our eyes, as it slides down over the eyeball to meet the lower eyelid (which hardly moves at all). The skin under the brows "unpacks" and the deep fold that exists there disappears. Depending on how fleshy the upper eyelid is, more or less of the eyeball's curvature can be discerned under the skin. If we scrunch up our eyes tightly, more muscles get involved – the eyelids push tightly against each other, the cheeks rise, and the eyebrows come together in a frown. This results in wrinkles radiating away from the eyes and down the nose.

10: Happy and smiling

When we smile, most of the action happens at the mouth. The corners move simultaneously up and back, stretching the lips thinly over the teeth. The upper lip lifts a bit, revealing the upper teeth, whereas the lower lip stays more or less where it is.



▲ When sculpting a smile, regularly check from below to ensure the lips are properly sliding over the teeth; note that the ears also rise slightly

cheekbone under fat and stretching the nostrils. The eyes tend to scrunch up to a degree, so that the lower eyelids thicken and deep wrinkles radiate away towards the sides. These wrinkles can extend halfway to the ear.

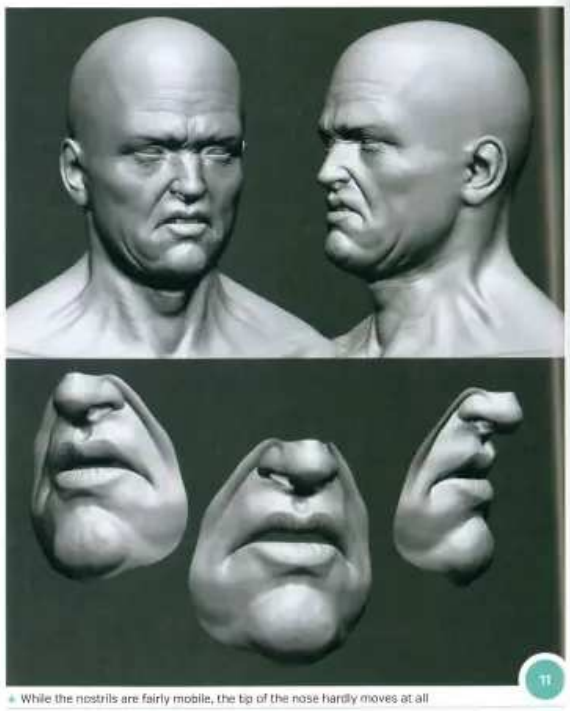
"Notice that this motion actually engages the tendons in the neck"

11: Angry and disgusted

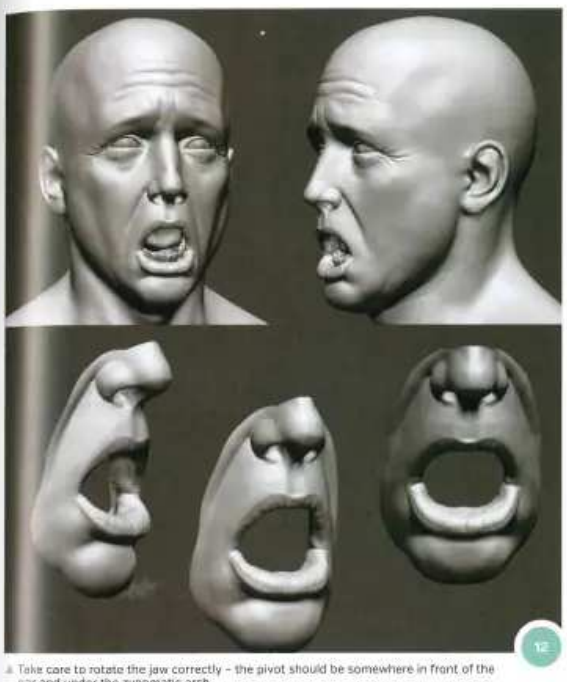
This is the sort of expression that involves the whole face. The nostrils lift while the corners of the mouth move down with the muscles underneath tensed. Notice that this motion actually engages the tendons in the neck. We also tend to thrust the jaw out a little while lowering the head, which results in thick folds under the chin. The cheeks don't shift much, but the eyes narrow, which can create minute wrinkles at the corners. There's a lot of creasing between the eyes, with the eyebrows bunching together and the skin down the nose wrinkling because of the nostrils.

12: Afraid and in pain

The opening jaw stretches the cheeks and pulls the nostrils down. As the corners of the lips tend to draw down when we're expressing negative reactions,



▲ While the nostrils are fairly mobile, the tip of the nose hardly moves at all



▲ Take care to rotate the jaw correctly – the pivot should be somewhere in front of the ear and under the zygomatic arch

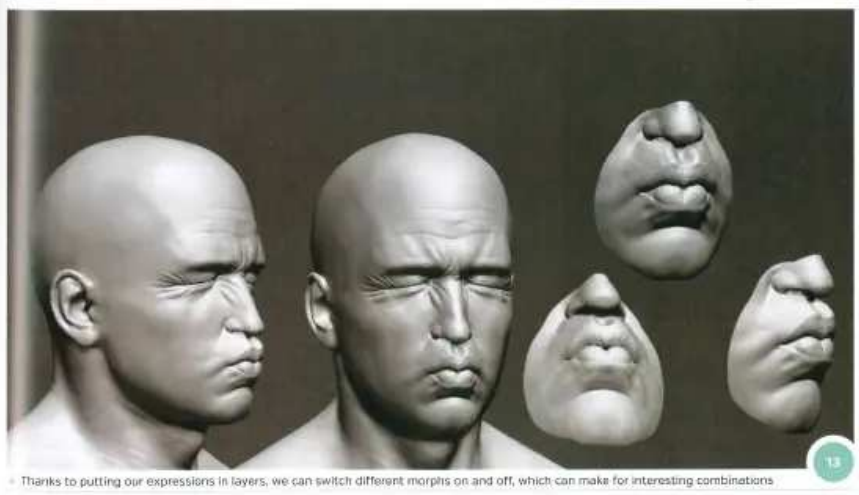
don't forget to bring out tendons in the neck as well. The mouth forms a round shape and the lower lip curls outward. This pose reveals the thickness of the lips, so inflate the corners accordingly. In the upper region of the face, the center of the eyebrows lifts, wrinkling the middle portion of the forehead. The eyes scrunch up at the sides, with the lower eyelids lifting. The main jaw muscles, the masseter and temporalis, pop out as well.

"When you push the lips together, take care to retain volume"

13: Forced to kiss grandma

This expression serves to showcase the mobility of the mouth. The muscle encircling the lips, called the orbicularis oris, can stretch and contract in a manner similar to a sphincter. When the mouth purses forward, it moves up and out and pulls the cheeks along as well. Sometimes even the jaw moves forward slightly.

When you push the lips together, take care to retain volume, which in this case means the lips grow larger and puffier as all the tissue packs together. The philtrum also becomes more pronounced and can almost plug up the nostrils.



▲ Thanks to putting our expressions in layers, we can switch different morphs on and off, which can make for interesting combinations

Sculpting an archetypal figure

Advanced 3D male

Part 02 | Shoulders, arms, and hands

By Djordje Nagulov

Freelance modeler

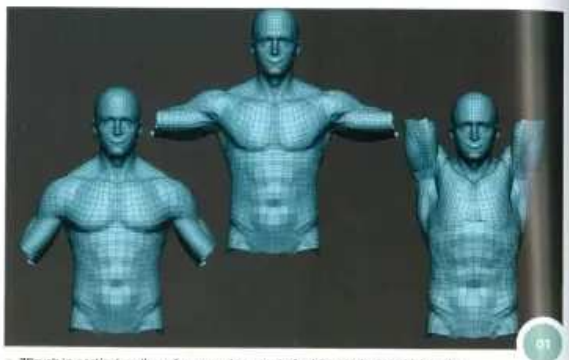
Having taken a closer look at the underlying anatomy of the face and how it drives expressions in the previous part, we now move down a step to examine the shoulders, arms, and hands by putting them into different poses.

To begin with, we'll rotate the arms from their resting position at the sides of the body up a full 180 degrees and consider the many parts involved in this motion. Then we'll roll the shoulders for good measure. The scapulae in the back and the clavicles in the front will both be closely looked at, as they displace a fair bit from their initial positions.

We'll consider proper muscle layering in the armpit, as well as how the different muscle groups stretch and compress.

Moving on to the elbow, we'll briefly remind ourselves of the way its bony landmarks shift as the arm bends, before examining the way muscles behave when the forearm rotates into supinated and pronated positions. We'll also discuss the importance of knowing muscle origins and insertions when a complex motion like this occurs.

Finally we'll look at the hand and wrist. Ranges of motion of the wrist will be determined, after which we'll examine how the hand forms different extreme poses such as a fist or maximally spread fingers. We'll consider how to sculpt the muscles, skin folds, and tendons in order to produce a natural-looking hand, as well as common pitfalls to avoid.

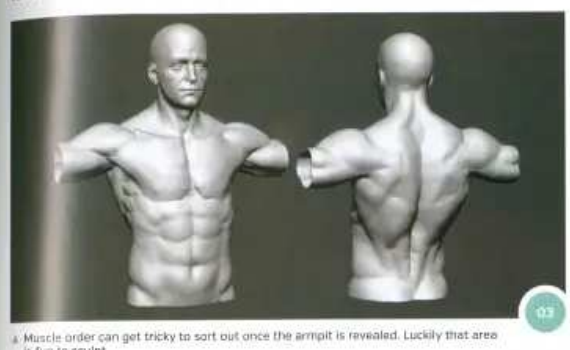


▲ ZBrush in particular allows for easy placement of arbitrary pivots, which makes locating the proper point for the rotation of the shoulder relatively easy

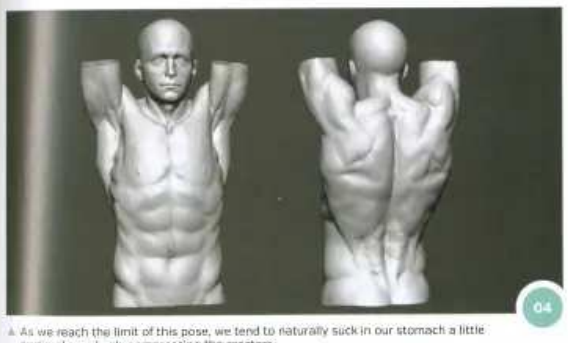
01: The process of posing

When dealing with complex joints such as the shoulders, no amount of careful masking and rotation will get you where you want to be straight away. Achieving more extreme poses

As you rotate the limbs, stretching and warping will intensify – it's a good idea to stop and adjust the mesh as this happens, to avoid a situation where the mesh is so twisted in on itself that it's impossible to untangle. You should not only nudge the edge loops back into place, but also sculpt the volumes back in, bit by bit.



▲ Muscle order can get tricky to sort out once the armpit is revealed. Luckily that area is fun to sculpt



▲ As we reach the limit of this pose, we tend to naturally suck in our stomach a little and arch our back, compressing the erectors

02: Arms at 30 degrees

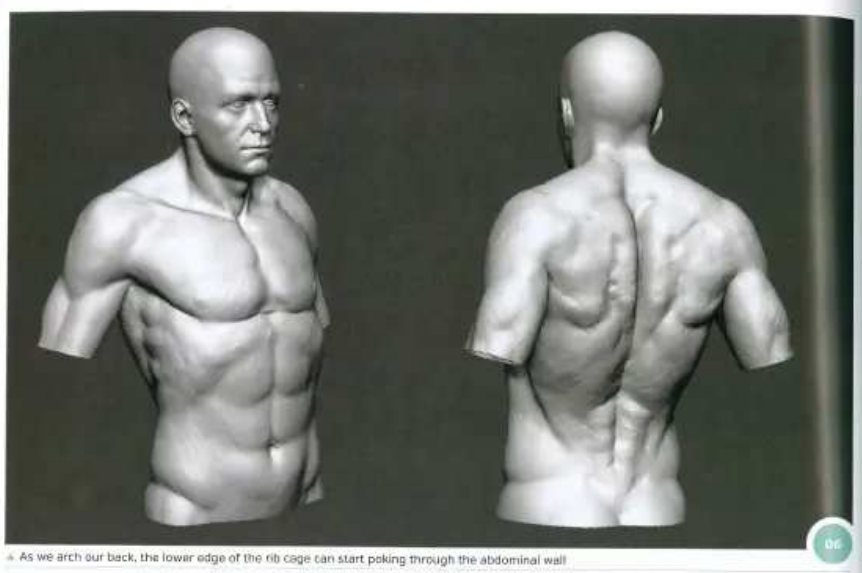
As far as posing goes, this is the easy one – rotate the arms 30 degrees out and you're done! Here's why: when we raise our arms above the head, our shoulders engage in what is known as the scapulohumeral rhythm. This phrase refers to the coordinated rotational movement of the humerus and scapulae. For the first 30 degrees or so, only the humerus moves, while the scapulae remain in place. After that, there's a 2:1 ratio at play – the upper arm generally rotates twice as much as the shoulder blades. In the front, the clavicles rotate upwards as well, although it's hardly noticeable at this stage.

03: Arms at 90 degrees

At this point the muscle masses shift noticeably, especially the pectorals. The bottom portion of the chest tends to lose volume the most as we lift the arm. On the back, the upper portion of the trapezius and the shoulder muscles serve as the primary drivers for this motion, so take care to sculpt in the tension there by making some secondary forms (the larger muscle strands) more pronounced. The upper arm muscles hang completely slack, so try to give them weight. As the armpit opens, be sure to have the latissimus and teres major tuck in together in front of the triceps.

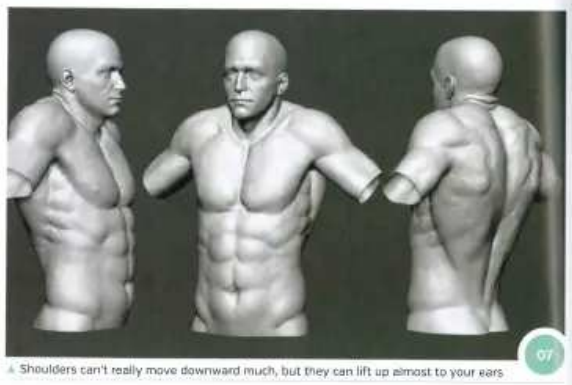
04: Arms at 180 degrees

Once the arms are raised above 90 degrees, the humerus rotates in its socket. This makes the shoulders face backwards as well, making the flat patch of the acromion completely visible from the back. The scapulae have rotated to their limit, stretching the latissimus dorsi and revealing the rhomboids which flow under the trapezius. Inside the armpit, the thin tube of the coracobrachialis slots in between the biceps and the triceps. By now the chest is spread really thinly over the rib cage, whose oval shape can be discerned more clearly now that the big masses have been lifted away.



▲ As we arch our back, the lower edge of the rib cage can start poking through the abdominal wall

all the parts behaving about as we'd expect. The clavicles take center stage, jutting out a fair bit, rotating forward beyond the horizontal. Noticeable dimples form both above and below the bone. The lower portion of the chest muscles contract and the whole area becomes compressed, so make sure you sculpt in the additional volume. As the trapezius angles forward, folds can form in the neck. In the back, the distance between the shoulder blades reaches its maximum, stretching the lower half of the trapezius flat against the ribs.



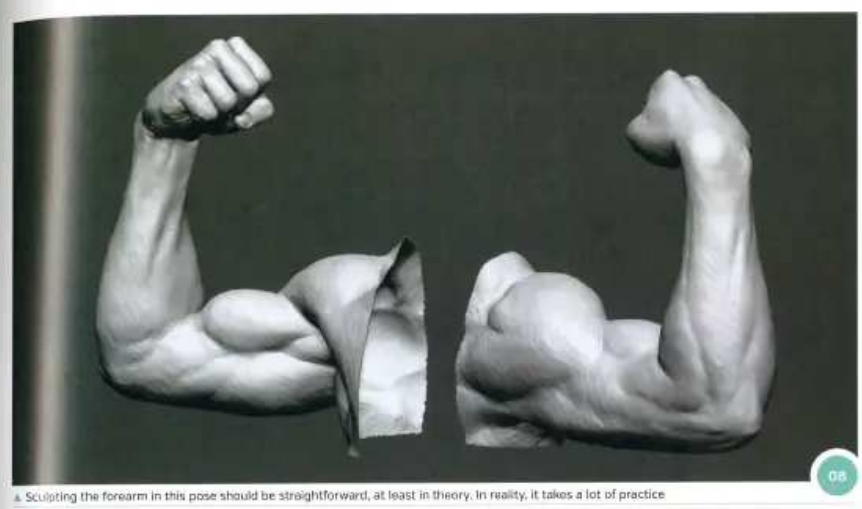
▲ Shoulders can't really move downward much, but they can lift up almost to your ears

06: Shoulders retracted

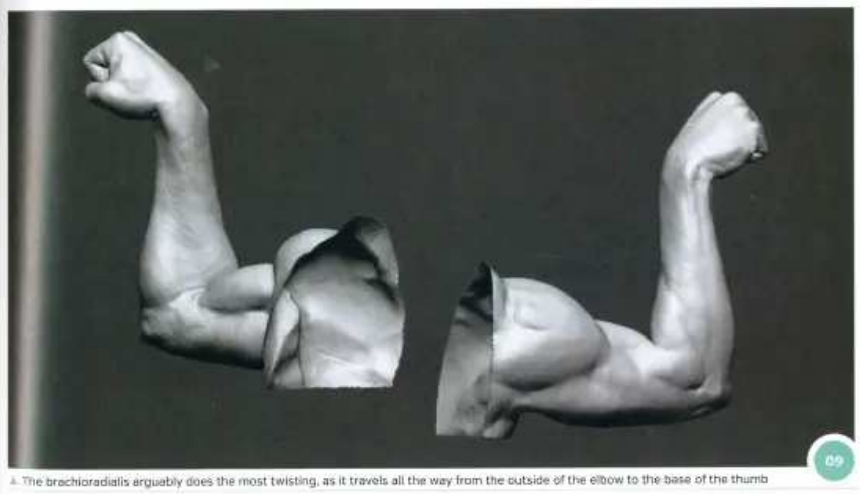
Pulling the shoulders back as far as they will go basically reverses the previous pose. Pinching the shoulder blades together engages several muscles and allows interesting topography to spring up on the back. The trapezius becomes both tensed and bunched together in between the scapulae, creating a lot of secondary bumps. These arise because the trapezius is a complex muscle composed of several discrete portions, which activate to a different degree. The spine tends to arch back as well, engaging the erectors. In the front this means the chest juts out, although the muscle itself is stretched thinly over the ribs.

07: Lifting the shoulders

Once again it's the trapezius that does a lot of the heavy lifting when we shrug, quite literally. Therefore you should make sure you give the muscle some tension in the back. As the shoulders rise, the upper slopes of the trapezius compress and push against the neck, creating deep folds under the skull. The clavicles rotate up to about 45 degrees, lifting all of the tissue and practically hiding the neck. The chest remains relaxed and doesn't stretch much unless the arms move, so most of the mass remains in place, just sort of hanging off of the clavicles.



▲ Sculpting the forearm in this pose should be straightforward, at least in theory. In reality, it takes a lot of practice



▲ The brachioradialis arguably does the most twisting, as it travels all the way from the outside of the elbow to the base of the thumb

08: Arm – bent, supinated

When the arm is straight, the epicondyles are roughly in line with the elbow. However, once the arm is bent, the elbow juts forward leaving them behind, so that they form a triangle, looked at from below. When the arm is supinated as in fig.08, the two bones in the forearm are uncrossed. We know that flexors attach on the inside of the elbow, whereas extensors attach on the outside, but the devil is in the details. Note that the biceps is shortened when the palm faces towards the shoulder. One of the two main tendons of the biceps creates that groove across the flexors.

09: Arm – bent, pronated

If you've already sculpted the supinated position, pronating the forearm is relatively simple. The radius crosses over the ulna, and all the muscles basically follow suit, twisting around them. Again, going down to a lower subdivision level and turning the mesh bit by bit is the best

▲ The fat pad below the fingers sits forward on the proximal phalanges and squishes down when you bend your fingers

approach, as the twisting will inevitably eat up volume and mess up the edge flow. It shouldn't take too much resculpting to fix, since the muscles have already been placed, but use a lot of reference as the silhouette will shift a fair amount. Don't forget to relax the biceps in this pose.

▲ If the fingers remain straight when the hand is raised up, their tendons will become visible. Sculpt them in, but don't overdo it

10: Hand – relaxed

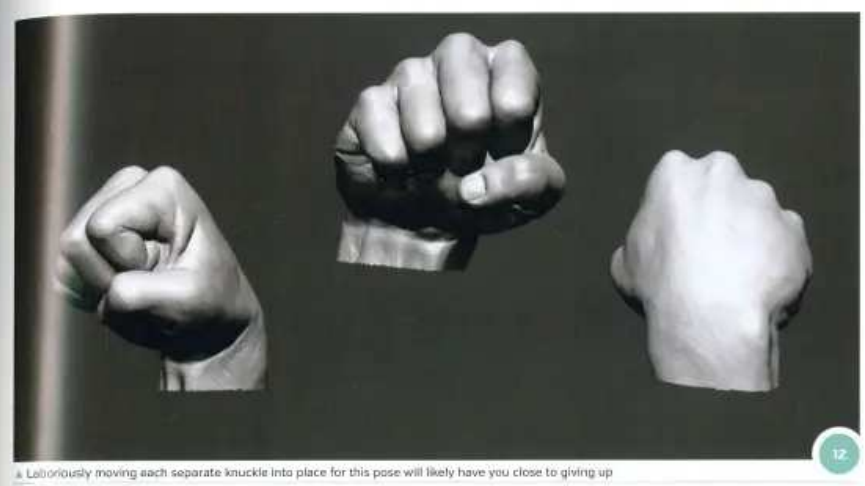
The fingers are slightly curled when the hand is relaxed. If you'll recall from the previous chapter, straight, parallel fingers should be avoided – each finger is somewhat crooked and bends to a different degree at rest. Although we tend to think of the hand as a flat rectangle, in reality it curves on every axis. Along with the slight concavity in the palm, it can be helpful to visualize the hand as resting on a large ball. Placing the thumb correctly is crucial to achieving a natural feel; note that nearly half of the thumb is actually part of the palm and greatly influences the shape of the hand as it moves around.

11: Hand – bending up/down

a lot more ground, a bit over 180 degrees in fact. Posing the hand at the extremes of this movement reveals no surprises, sculpting-wise – folds form on the bent side, whereas the skin is stretched thinly on the opposite side. the subtle variations in height that occur in the cross-section of the wrist.

12: Hand – making a fist

We tend to think of fists as squarish blocks, but they are rather oblong from



▲ Laboriously moving each separate knuckle into place for this pose will likely have you close to giving up

▲ With so many moving parts and possible poses, it's easy to miss an angle where the hand doesn't look right. Check and correct constantly

skin folds on each joint are stretched thinly over the bone, while the base knuckles form a procession of small hills and valleys. Since the metacarpals of the last two fingers are fairly mobile,

13: Hand – fingers spread

When we spread our fingers, we tend to raise them slightly as well, which makes the tendons pop out. This motion bunches up the folds on top

faint bulges of the proximal phalanges connecting to the metacarpals.

The fingers themselves aren't merely straight in this pose, they tend to

We can't really move our hands side-to-side that much, there's less than a 90 degree range in total. Up and down (extension and flexion) covers

Keeping the volumes intact is once again our main concern. Try using your own hand as reference in order to capture

most angles. Although it's not quite visible in fig.12, bunching your hand into a fist makes all the large tendons on the inside of the forearm pop out. The tiny

this knuckle line describes a pronounced arc. There are many complex repeating shapes in a fist, so once again be on the lookout for vitality-sapping parallel lines.

of the knuckles, conversely stretching the skin on the underside. The plump finger pads also disappear. Notice how all the stretched skin even reveals the

curve upwards slightly. The thumb rotates away from the palm as far as it can go, popping out its own tendons and pulling all the loose skin taut.

Sculpting an archetypal figure

Advanced 3D male

Part 03 | Torso

By Djordje Nagulov

Freelance modeler

Our anatomical journey continues with the torso. Having braved the complex biomechanics of the scapulohumeral rhythm and twisting the forearm, no pose the torso can throw our way should be able to faze us.

To examine how the torso moves, we'll pose our sculpt in extremes of motion, generally involving rotating the torso on every axis while noting the limbs' positions and keeping track of the underlying skeleton.

Since the shape doesn't change that much, it's fairly easy to pinpoint the torso's major muscle groups, but it's still important to understand how bending the spine changes the silhouette by compressing and distending the muscles. We'll also consider the role that skin plays in the visibility of secondary forms.

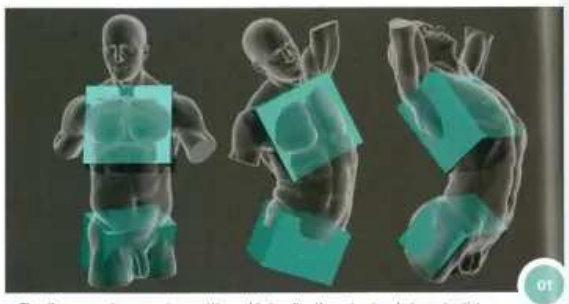
We'll go in-depth with balance, learning to pose a figure with believable weight, and what pitfalls to avoid. Finally we'll revisit the concept of gesture and how important it is in imbuing a sculpt with vitality.

"Beginners often make the mistake of disregarding the fundamental volumes, just enough for the body to lose its internal structure"

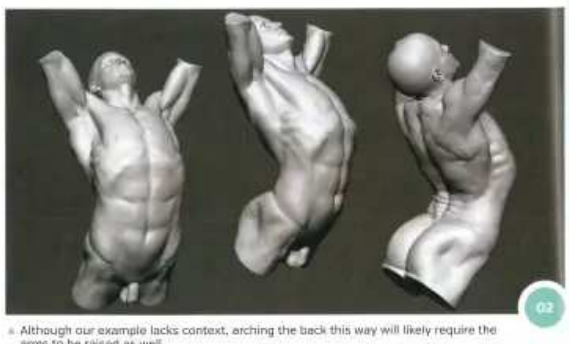
01: The fundamentals

It's easy to lose sight of the importance the skeleton has in holding the volumes on the torso, once it's concealed by all of the fun-to-sculpt muscles. Beginners often make the mistake of disregarding the fundamental volumes, just enough for the body to lose its internal structure.

The pelvis and rib cage are superficial elements of the skeleton, in that they have many landmarks sitting at or near the surface. Their shape and size provide most of the torso's form, but except for the rib cartilage, they can't really shift or compress. This is crucial to keep in mind as we contort the body in ways which can obscure the underlying construction. One simple way of doing this is to visualize the torso as a tube with two large boxes stuck inside. All of the other tissue goes on top and compresses and expands as required, but the boxes themselves



▲ The rib cage and torso as boxes. We could visualize the spine too, but most artists know the human body doesn't squash and stretch much (outside of a torture device)



▲ Although our example lacks context, arching the back this way will likely require the arms to be raised as well

must remain inviolate. This ensures that the proper volumes remain intact.

02: Bent over backwards

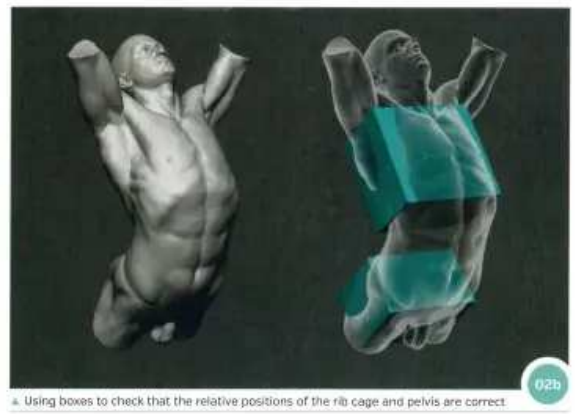
Bending backward to any great degree is difficult for most people who aren't very fit, men more so than women (fig.02a). Most of us can manage a gentle curve; really flexible people can effect a curve so extreme it looks more like a break.

Most of the bending occurs around the lumbar vertebrae, the relatively small portion of the spine that's free of other skeletal structures, between the rib cage and the pelvis. So when masking the sculpt and placing the pivot, make sure you leave the upper region of the spine unaffected, and likewise with the hips, otherwise you'll get unwanted distortion (fig.02b). It helps to think of it is as two solid masses connected by a spring.

Leaning backward stretches the abdomen taut, flattening the six-pack and revealing the bottom edge of the rib cage, while severely compressing the back's erector muscles, causing a lot of skin-bunching. These folds are likely to be quite thin and numerous due to the sinewy nature of the tissue underneath. A deeper fold will visually separate the back from the buttocks in this pose: depending on the rest of the body, the buttocks may be clenched for balance, so be sure to sculpt in the tension.

03: Leaning forwards

The spine isn't able to bend forward nearly as much as backward. In front,



▲ Using boxes to check that the relative positions of the rib cage and pelvis are correct

the most notable change happens in the stomach, and is greatly affected by age and fitness (fig.03a). Men especially tend to accumulate fat in this area, which can produce large skin folds on a convex belly, sitting far ahead of the rest of the torso. Even in a body more like the Greek sculpture ideal, it's important to push the abdomen out, retaining the volume of all the masses being compacted in between the ribs and hips.

"On the back, note that the curvature of the spine isn't uniform like a parenthesis; it tends to get sharper toward the neck"

In fit people, the skin folds are much thinner and generally localized around the navel, which tends to become horizontally squashed and lost in the folds. There's also a noticeable angle change at the navel, where the six-pack folds in to sit on top of the lower abdominal wall, rather than forming a smooth curve as might be expected (fig.03b).

On the back, note that the curvature of the spine isn't uniform like a parenthesis; it tends to get sharper toward the neck. Bending forward like this also makes the lumbar portion of the spine peek out between the taut erectors, so the small bumps of the vertebrae, usually hidden in a deep valley, become clearly visible. When the latissimus dorsi gets stretched thinly over the rib cage, individual ribs can be seen underneath, creating interesting secondary surface forms.

▲ Being able to touch your toes depends on the laxity of your leg tendons more than on the rotation in your spine!

▲ Note how the abdominal muscles bunch up between the masses of the rib cage and pelvis

04: Bending to the side

As far as sculpting goes, this pose breaks symmetry almost immediately. If you're proactive about layer use, you might get a good head start on limb positioning, but otherwise each half of the body needs to be worked on separately. When rotating the upper torso into place, be sure to keep the rib cage's form intact, as it's easy to lose sight of it and sink the compressed side in too much (fig.04a). Similarly, don't let the mesh at the hip area dip down.

The external obliques change shape the most. On the bent side, the oblique muscle is shortened and hidden behind thick skin rolls, while it's taut on the far side. Don't be shy about sculpting in deep wrinkles which travel halfway around the front and back. While half of the rib cage becomes obscured by deep folds, its egg-like shape becomes more distinct on the extended side as the muscles stretch thinly over the underlying bones (fig.04b). Bending sideways also engages the erectors; the furrow in the upper back remains quite straight, as most of the curving occurs in the lumbar region.

05: Twisting the torso

Twisting the body along its longitudinal axis requires the least amount of re-sculpting work (fig.05a). The spine remains straight, perhaps tilting back slightly. The arms tend to help with the torsion by swinging ahead and back, so the scapular shifting over the rib cage and subsequent distortion of the trapezius need to be sculpted in. Similarly, the pectorals stretch on one side and compress on the other, but keep in mind that this derives solely from the upper arms and has nothing to do with the spine rotation itself.

The external obliques are the primary drivers of this motion and where most of the modest form change happens (fig.05b). On one side, the muscle will stretch slightly as the origin and insertion points at the ribs and hip travel further away; on the opposite side, the diagonally running striations will "un-skew" almost to vertical. Some skin folds may form at the waist on the distended side, depending on fat distribution and the amount of looser skin.

06: The classic *contrapposto*

The rigid, symmetrical pose we initially sculpt our figure in is hardly natural. Throughout the sculpting process, we've worked hard to imbue our sculpt with vitality in the body's forms and S-curves. In reality, we tend to naturally assume stances pleasing to the eye, which goes a long way to making a figure feel dynamic even at rest. *Contrapposto* ("counterpose" in Italian) is the most widely used stance for a standing figure, wherein one leg carries most of the weight (fig.06a).

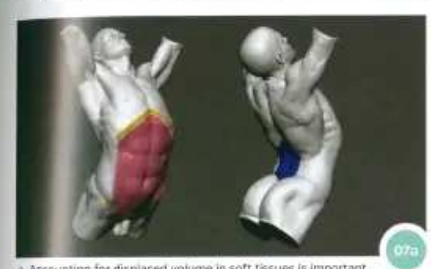
The dynamism of *contrapposto* comes from the hips tilting one way, while the shoulders compensate by tilting the opposite way (fig.06b). Additionally, since one of the hips is lowered, that leg usually stands half a step ahead of the body, slightly bent. Secondary form changes are minor but should be noted. The oblique muscles on the raised side compress against the rib cage, but it's the backside that should receive the most attention – one buttock is compressed by the straight leg and bulges out, with a strong crease at the beginning of the thigh; the

▲ A good example of the duality of compression and extension

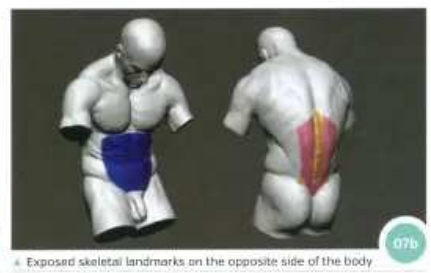
▲ The underlying skeleton shouldn't lose its form in this pose

▲ Michelangelo's *David* exemplifies the *contrapposto* stance

▲ Capturing the opposing angles of the shoulders and hips



▲ Accounting for displaced volume in soft tissues is important



▲ Exposed skeletal landmarks on the opposite side of the body

other is relaxed and descends lower, the crease being much less noticeable.

07: Compression and extension

In areas of the body with complex joints and rotations beyond 100 degrees, keeping track of the muscle groups can be tricky. As the torso isn't very mobile, the muscles and other tissues change shape, rather than position (fig.07a).

This mostly happens due to the compression and simultaneous extension of the forms on the opposite side of the body. The artist must learn how the affected areas look and re-sculpt accordingly. Not only do the muscles and skin distend and compress, but previously obscured bony landmarks can spring to prominence. As you can see in fig.07b, compressing in one direction exposes skeletal landmarks on the opposite side of the body

notices if the center of gravity isn't where it should be – we feel tension, as if the sculpt is about to fall over at any moment. Using *contrapposto* as an example, leaning the hips too far out or not shifting the foot underneath the body would create this tension. You should generally be able to draw an imaginary line straight through the figure's head, hips, and load-bearing foot.

The whole body gesture also needs to be considered. Reduced to a single stroke, even the *contrapposto* stance can be abstracted into a long S-curve. A well-posed sculpt should have one or several of these flowing action lines, which naturally lead the eye from area to area. Straight and parallel lines can lend a figure a deadly sense of stiffness and should be introduced only with good reason.

05a

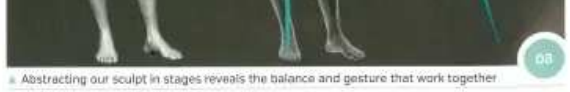
▲ Most of us can't really twist very far on this axis

05b

▲ The motions of the rib cage and pelvis are more subtle here

08: Balance and gesture

One error even experienced artists can commit is not paying attention to a sculpt's overall balance. Our eye easily



08

▲ Abstracting our sculpt in stages reveals the balance and gesture that work together

Sculpting an archetypal figure

Advanced 3D male

Part 04 | Legs, groin, and feet

By Djordje Nagulov

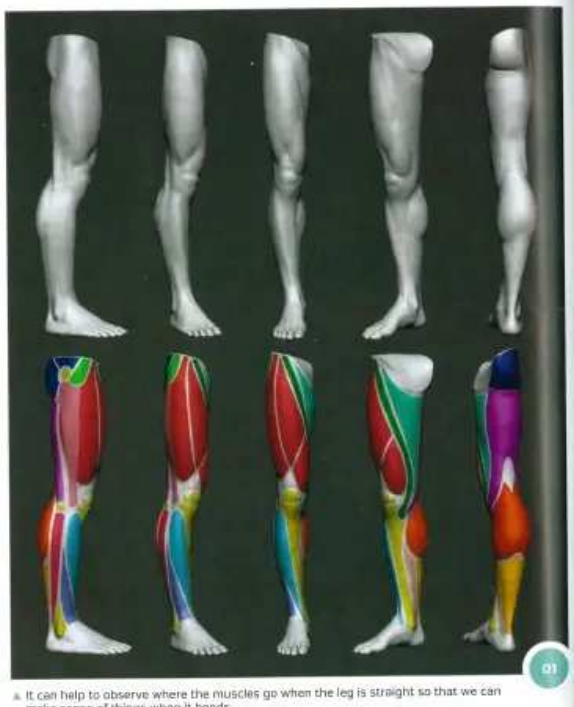
Freelance modeler

Having gone over most of the rest of the body in the previous three parts, in this final part on posing the human figure we will be concentrating on the lower portion of the body, namely the legs, groin, and feet. Legs and feet will be swung in the cardinal directions, toes flexed every which way, and even the backside will get some attention.

We will take a look at the changes which occur around the hip and knee when the leg is swung in two different poses, first halfway up with the thigh horizontal, and then nearly pressing against the torso. Both of these joints undergo significant changes in the positioning of muscles and bony landmarks as they rotate.

In order to parse these shifts properly, we'll also take a look at the bent leg with all the major muscles painted in so that we can discern what moved where and what might be causing all those secondary forms on the thigh.

Then we'll move onto the foot and toes, examining their range of motion on the up/down axis through three different poses, while noting how flexing the foot influences muscles in the calves where appropriate. We'll also compare how the toes behave when pushing against the ground versus when they are standing free.



01

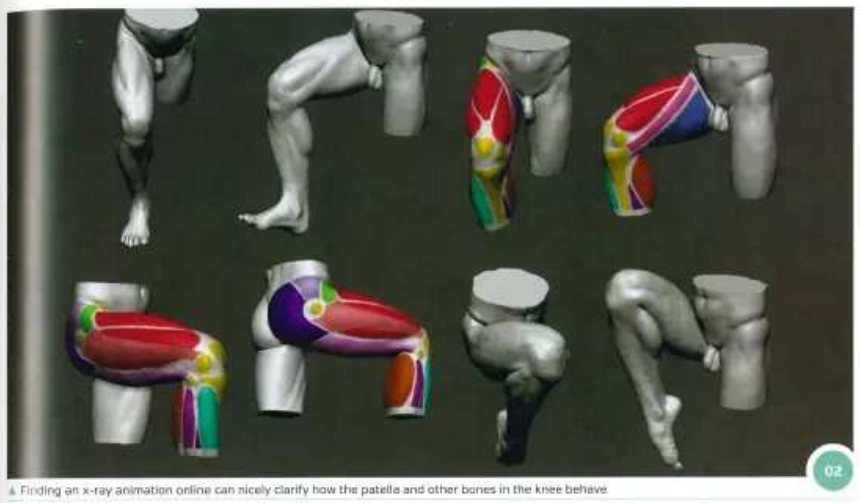
▲ It can help to observe where the muscles go when the leg is straight so that we can make sense of things when it bends

01: The straight leg

If you use the bony bump of the femur on the side of the hips as a starting point (the greater trochanter), the actual ball and socket joint sits just slightly above it. Keep that in mind when trying to find the proper pivot for the leg. Come rigging time, this area, along with the shoulders, is likely to be the toughest to skin correctly due to the fact that the thigh and torso must both keep their volumes, yet the pivot is so deep inside the pelvis that they squash together a fair deal.

Sculptors have it easier, but even then finding the correct place for the crease at the front of the hips can be tricky.

This crease is very deep, and runs diagonally from the pubic symphysis (basically where the genitals are) to just under the bony tip of the iliac



02

▲ Finding an x-ray animation online can nicely clarify how the patella and other bones in the knee behave

crest at the front of the hips (the anterior superior iliac spine – quite the mouthful for such a tiny feature).

02: The leg at 90 degrees

The knee itself can be tough to parse, but it's not actually that complicated once you understand where the many bony protrusions go. First you have the plateau of the tibia, above which the patella sits. Right behind the patella are the two epicondyles on either side. When the knee bends, these condyles "roll" across the plateau, becoming more pronounced as the skin stretches, while the patella angles back, slotting neatly in a little groove between them.

It's important to note that the mass of the quadriceps is attached to the patella by a tendon, which doesn't stretch – make sure you retain the relative distances in the area, as the actual stretching will happen in the muscles.

Note that even as the muscles at the front of the thigh stretch, the sartorius belt on the inside and the biceps femoris on the outside (attaching to the head of the fibula) both actually shorten. In

03

▲ Sitting down with your legs folded under you can be rather uncomfortable if your tendons aren't up to it

the back, don't forget to remove some of the volume from the buttock.

03: The leg at 140 degrees

Lifting the leg further above horizontal does not produce any great anatomical changes in the pelvis area, mostly a continuation of the same tendencies from the previous step; the crease at the hips grows and gets deeper, the thigh and the abdomen press against each other, and the buttock loses more volume as it stretches further, which makes the greater trochanter more visible.

The whole knee area forms a sort of plane at this extreme angle – don't make the mistake of rounding it out too much as it's actually fairly flat when looked at from the side. The patella is angled back, the condyles have rolled back on the tibial plateau, and the small bump at the front of the tibia (where the patella attaches by tendon) is quite prominent.

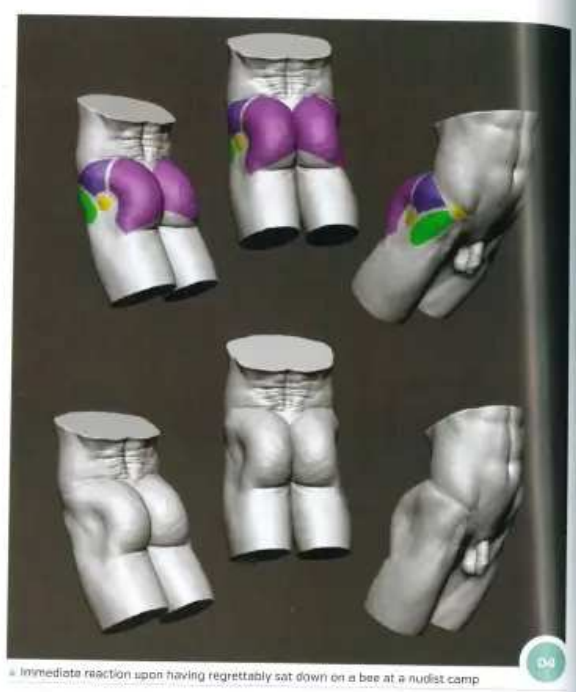
Behind the knee the calves meet the back of the thigh in a graceful crease, somewhat flattening both parts of the limb. The knee can bend even further – the soles of the feet can easily touch the backside when sitting seiza-style, with the weight of the body pressing down. To account for the compression of the muscles, you'll have to sculpt in the extra flaring of the calves on both sides of the leg, as that volume has to go somewhere.

04: Swinging the leg backwards

While you can easily bring your knees all the way up to your chest, the leg doesn't bend nearly as much in the other direction. Pretty soon the spine starts arching to accommodate further rotation, rotating the pelvis back. In front this brings the bony nubs of the anterior superior iliac spine forward, possibly even peeking out from under the obliques. On females the asis tends to be more visible as it is, due to lesser muscle mass, but in thinner people thrusting the pelvis forward like this can make the bones of the hips positively jut out from under the skin.

Swinging the legs backwards utilizes the large gluteus muscles. As the muscle contracts, its two different portions become more clearly delineated, with a distinctive hollow forming on the side of the hips where the greater trochanter is.

Note that while gender and age variations apply, a fair percentage of the buttocks is made up of fat pads, especially in women. Once again you have to pay attention to overall volume – whereas we had to sand off some of the roundness when the leg was rotating forwards, now all that mass bunches up as it's pushed against the back edge of the iliac crest by the femur, forming a crease there as the angle increases.



04

▲ Immediate reaction upon having regrettably sat down on a bee at a nudist camp

05: Standing on tip toes

Technically this should be termed as standing on the balls of our feet, as they are best able to bear the weight of the whole body. The toes and the bean-shaped pad behind them make strong contact with the floor while the rest of the foot rises up off the ground. The foot can rotate down (plantar flexion) a great amount, nearing vertical. The toes are bent close to their limit in this pose, gripping the ground, and this tension should come across in the sculpt. As the heel is up in the air, the bottom of the fat pad should be rounded out a bit, but a sharp angle shortening them and giving them a more chiseled feel. Once again, try not to skimp on foot anatomy – there are some lovely curves going on in the sole, and getting them right can be satisfying. Don't neglect to put in the skin creases at the heel and big toe, as they lend believability to the sculpt.

06: Toes pointing straight down

Compared to the fingers, toes have relatively limited individual mobility and tend to move as a single unit, big toe excepted. Curling them downward happens mostly at the base of each toe, so be sure to sculpt in the angle change that appears at the knuckles. The toes bunch together and push into

front of the foot where the metatarsal of the big toe meets the rest of the foot also becomes more prominent.

Although we tend to think of feet as relatively flat, pointing the toes like this can introduce substantial curving in the sole. If you look carefully you'll notice this curve isn't of an even nature, as there are definite "breaks" in a couple of places, generally where the joints meet.

PROTIP

Wet footprint

Recalling the comparison to a wet footprint in fig.16 on page 108, try to mentally map out the different

07: Rotating the foot up

Just as pointing the foot down engaged the calf muscles, rotating the foot up like this (dorsiflexion) flexes the muscles in the shin area. The large tibialis anterior muscle in particular (which, if you'll recall from page 106, actually describes the silhouette of the leg ahead of the tibia, when looked at from the side) jumps out in this pose. Don't forget to also sculpt in its tendon as it pops out crossing over the ankle.

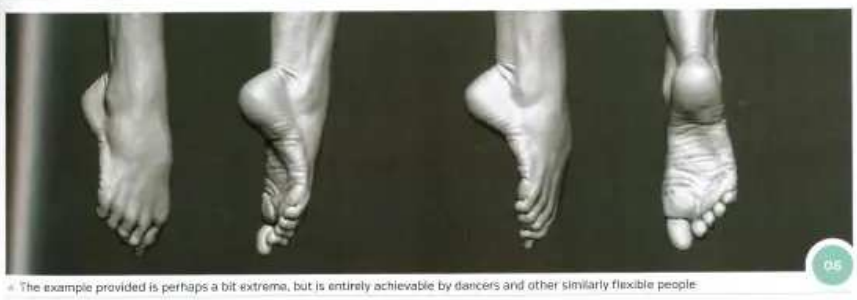
In the back the Achilles tendon is stretched as the heel bone moves down; there's a slight angle change where the tendon attaches to the bone and then transfers into the fat pad of the heel.

Under their own power, the toes can't bend nearly as much as when they are pushing against a surface. When locating the pivot, keep in mind that the phalanges actually end a little way inside the foot. Even though the toes generally move in unison, try to introduce a bit of variation in their height, as some can rotate more than others.

Similar to the hand, lifting the toes will bring out the tendons on top of the foot. Note that the tendons all converge toward the front of the ankle – they aren't parallel. The one notable muscle on the foot itself, the extensor digitorum brevis sitting in front of the outside ankle bone, also tends to bulge out in this pose.

05

▲ The visual lengthening of the leg and the accentuated curve of the calf are likely why high heels remain popular



06

▲ The example provided is perhaps a bit extreme, but is entirely achievable by dancers and other similarly flexible people

change should still be visible at the sole.

The rest of the leg shouldn't be neglected – raising up like this tenses the calves,

areas of the sole when sculpting, as its topography is actually fairly complex, much like our palms.

▲ When rotating the foot, take care to keep the leg bones straight as it's easy to introduce a kink in the ankle that shouldn't be there

Sculpting an archetypal figure

3D female

Part 01 | Basic form

By Mario Anger

Animator

This chapter will look at how to get started when sculpting a realistic female figure in a 3D space. Simple shapes will be used to establish the gesture of an archetypal female character in a relaxed standard T-pose. I'll explain two ways you can create an initial base figure: building up with spheres and beginning with primitive shapes. I will then go on to explain how to adjust female body proportions and prepare a mesh ready for sculpting the structures of muscle, skin, and fat.

After that, we will look at the important combination of hard and soft surface parts. We will also look at how to refine the key skeletal protrusions and bony landmarks of the figure (such as the elbows, collar bones, and ankles), and how they alter the silhouette of the figure itself.

"To start off, try drawing spheres on the canvas. Most 3D softwares have a Mirror function, so you only have to work on one side of the figure with this function enabled"

01: Using spheres by starting with the torso

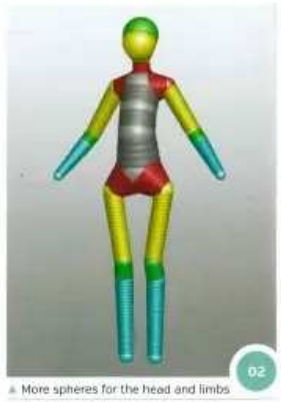
There are several ways to start a figure in a 3D application. For example in some sculpting software you could place distinct points of the character roughly in position and connect them later to form one sculptable mesh.

To start off, try drawing spheres on the canvas. Most 3D softwares have a Mirror function, so you only have to work on one side of the figure with this function enabled. The starting point would be the pelvis region as that's where the figure will have its center of gravity. A few more spheres are placed above it until we reach where the neck would start.

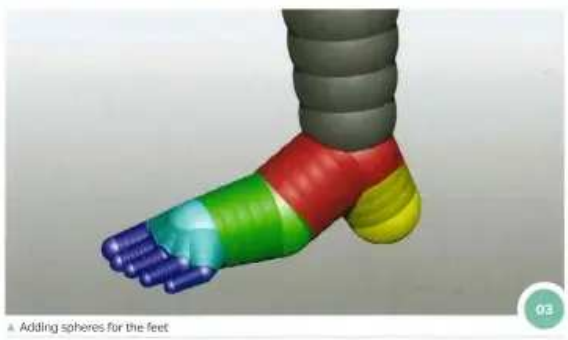
▲ Using spheres to create the torso

02: Limbs and head

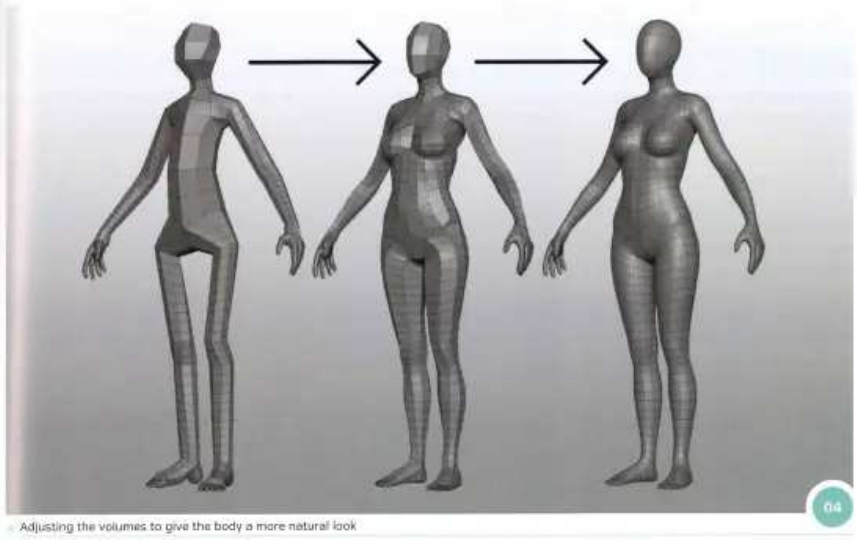
Another sphere should be added to the neck where it meets the head and then two more should be added in order to create a slightly oval shape for the skull and face region. For each limb there should be spheres



▲ More spheres for the head and limbs



▲ Adding spheres for the feet



▲ Adjusting the volumes to give the body a more natural look

at each end point, as well as a few in between for the bending joints.

The shoulder spheres are placed below the neck. Likewise, each leg starts with a sphere to the left and right of the hips. For every joint, set up two spheres. This is because there are plane changes happening here that cannot be accomplished with just one point.

03: The feet and hands

The feet need three spheres: one for the heel, ball, and beginnings of the toes. Each toe should also get its own spheres, one to three depending on which toe you are working on. The hands should have a similar build to this.

If everything is roughly in place, you need to transform the spheres into one sculptable surface. See the pro tip box on the right here to get an idea of how to create quadratic-shaped polygons.

"You can add more resolution to parts of the body where you need it"

04: Adjusting the proportions

The mesh now has all the necessary features of the human form, however the volumes of these features are not in proportion. You will need to adjust the volumes so that they look more realistic. This will involve smoothing out the lines and adding curves in the right places.

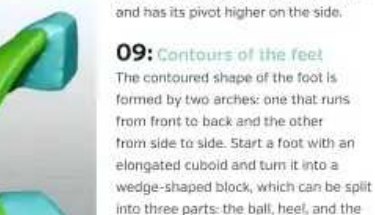
It is a good idea to frequently refer to observation of human bodies, whether this is looking at a real human or a photo. You can also take a look at page 159 for a proportion guide.

At this point it doesn't have to be one hundred percent correct, but it's easier to start with a more natural base. You can add more resolution to parts of the body where you need it. The highest details will appear in the face region and therefore this area needs the most density.

PROTIP

Make adaptive skin

To transform spheres (ZSpheres) into one sculptable surface in ZBrush, go to Tool > Adaptive Skin > Make Adaptive Skin. The Density slider controls the resolution of the final mesh.



▲ Smoothing out the skin with the Adaptive Skin function

05: Starting from a spine

Building up spheres is one way to start a digital figure. But since legs, arms, head, and torso are combined into one object, it's harder to adjust individual parts to place them perfectly.

To preserve more flexibility, you can also start by building up basic objects for the eight parts of a human figure. These include the rigid bodies of the head, the pelvis, the spine, the rib cage, plus two arms and two legs.

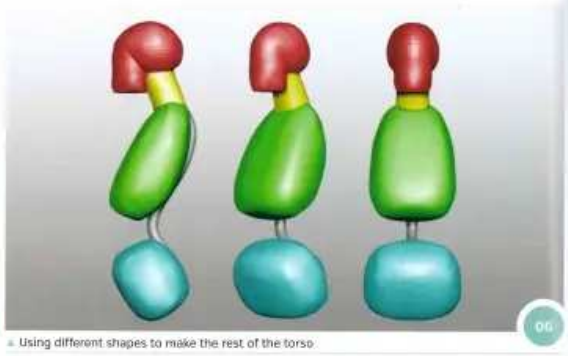
A good place to start is the spine. Create and bend a cylinder to form the spine's S-shaped curvature, but keep it more or less a straight line from the front.

To capture the poise of a human body you need to understand that it is basically designed for movement. There is a constant balancing act between parts when the pose is changed. The spine adjusts the position of the three major masses (pelvis, rib cage, and head) in relation to each other.

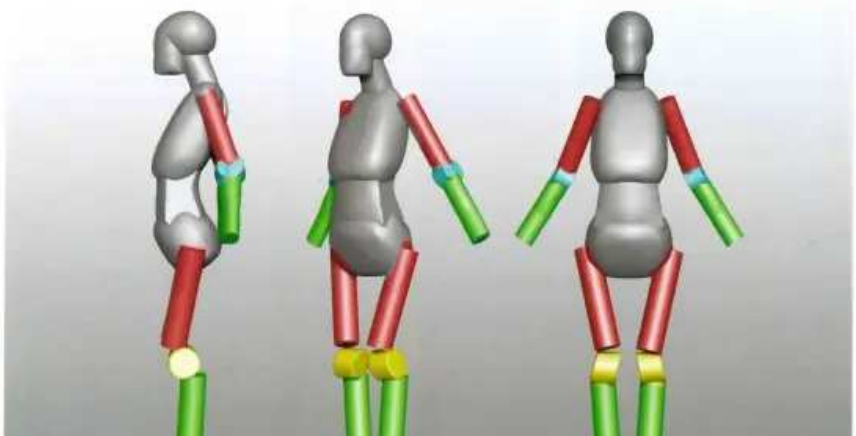
06: Adding the head, neck, rib cage, and pelvis

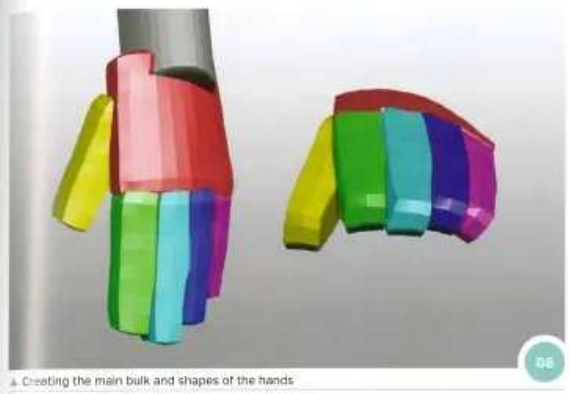
Follow the line of the spine to place the pelvis – in this case a smoothed cuboid, tilted forward and rotated back, at the lower end. Place another smoothed cuboid for the rib cage. This should be narrower at the top, rotated in opposition to the pelvis, and positioned at the upper half of the spine. For the neck add a cylinder, following the S-curve of the spine. This allows the head to slightly jut out ahead of the body.

▲ Stretching a cylinder to create a spine



▲ Using different shapes to make the rest of the torso





▲ Creating the main bulk and shapes of the hands

07: Placing the limbs

For now, the arms, legs, elbows, and knees can be represented as cylinders. On females the lower arms are bent outwards at the elbow due to the tighter shoulders and wider hips.

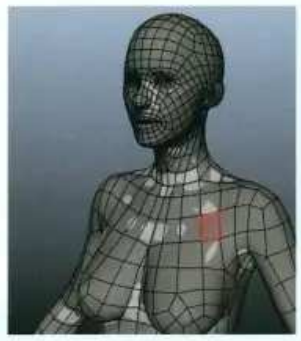
"To get an interesting flow when the eye travels down the body, it is a good idea to rotate the different elements away from each other"

The upper legs face forwards at the top and turn gradually to point towards the midline of the body. Again, for stabilization reasons, the knees are rotated outwards and backwards and the lower legs do the same again. To get an interesting flow when the eye travels down the body, it is a good idea to rotate the different elements away from each other.

PROTIP

Maya's Quad Draw tool

An even-spaced topology is better for sculpting because the figure will have the same resolution for detailing everywhere. It's also always better to have faces with four edges; any more will cause trouble if you sculpt on them. You can go into an application like Maya and retopologize the faces per hand on top of the existing topology.



▲ Using the Quad Draw tool to even out the topology

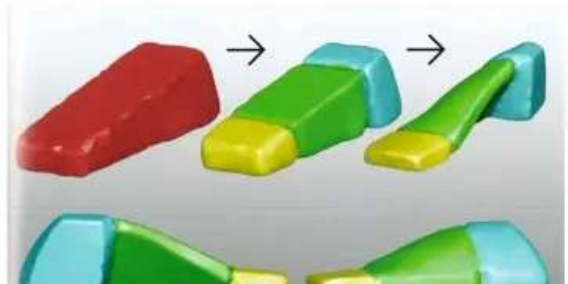
08: Making the hands

Rotate the hands slightly so that they are at a different angle to the forearms (so if the forearms are facing away from the body, the hands should do the opposite).

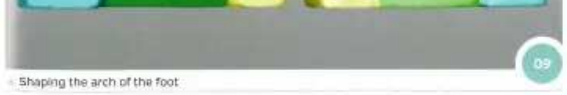
The hands are created from two rectangular boxes. Split one box into four separate boxes to form the fingers. Curve the tips slightly and make sure the middle finger is the longest. The palm should bend downwards a little. The thumb is able to rotate on a different axis to the other fingers and so it faces the fingers and has its pivot higher on the side.

09: Contours of the feet

The contoured shape of the foot is formed by two arches: one that runs from front to back and the other from side to side. Start a foot with an elongated cuboid and turn it into a wedge-shaped block, which can be split into three parts: the ball, heel, and the bridge connecting between them.



▲ Using cylinders for the limbs; don't forget that they don't come straight out of the body at right angles!



▲ Shaping the arch of the foot

On the inside of the foot there is an arched void which helps to stabilize and balance the body when walking and performing upright activities.

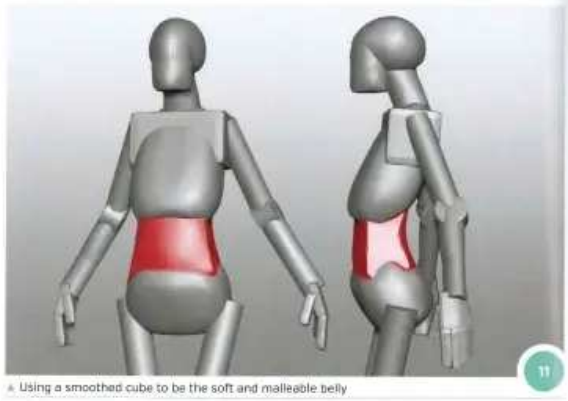
▲ Three views of the box used to mimic the shoulders

10: Placing the shoulder girdle

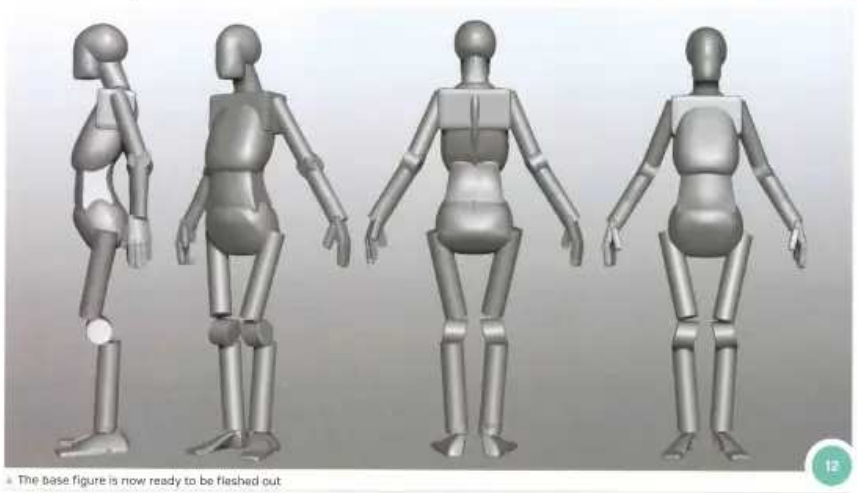
The shoulder girdle is a construct that contains the clavicles (collar bone) and scapula, connected by the acromion. It sits right over the rib cage and enables a large range of movement for the arms. To put in a placeholder for this you can build a wide cube. The front edge acts as the clavicles, the side edges as the acromion, and the back plane represents the scapula bones.

11: Connecting the abdomen

You are left with a gap between the rib cage and the pelvis, which is of course the abdomen. In contrast to the rigid parts of the bony structure, this area will be stretched and squashed when the body is moving, so you need to fill it with an extra form that represents the soft material of the belly. For the time being you can simply rough in a smoothed cube.



▲ Using a smoothed cube to be the soft and malleable belly



▲ The base figure is now ready to be fleshed out

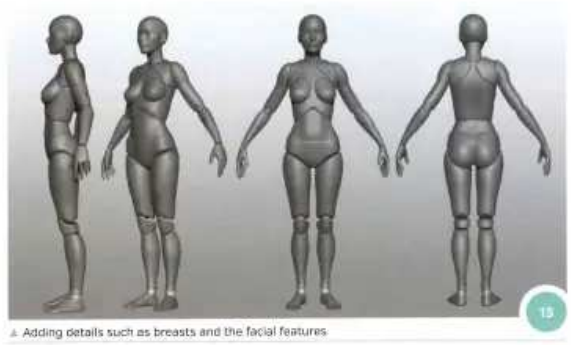
12: Completing the base figure

All major parts of the figure are created and placed now, and since they are still separated, it's easy to adjust the overall gesture and position of each element in conjunction with other elements.

The movement for the center of the body, for example, can still be changed. It's most visible in the side view. The point that leads the body and is pushed out furthest can be the pelvis, stomach, chest, or even the head. It depends on the mood and character of the figure.

13: Refining the parts

At this point we can start making the shapes softer, which will ensure a more natural look for the model. We should also think about the breasts, because they will have quite an effect on the posture and overall look of the sculpt. For now we will use half spheres for these, shaped like a tear drop from the side. It's important to remember that they are not just sticking out of the body; they are actually affected by gravity and pull down a little.



▲ Adding details such as breasts and the facial features

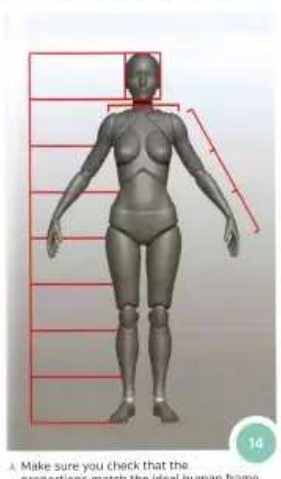
While we are working on the torso, the shoulder girdle can be split down the middle. As a result of this, it is possible for both shoulders to be moved individually, which can be useful. It is a good idea to spend a little bit of time refining the detail at this stage, for example separating the toes out of the feet and adding ears and a nose to the head.

14: Adjusting the proportions

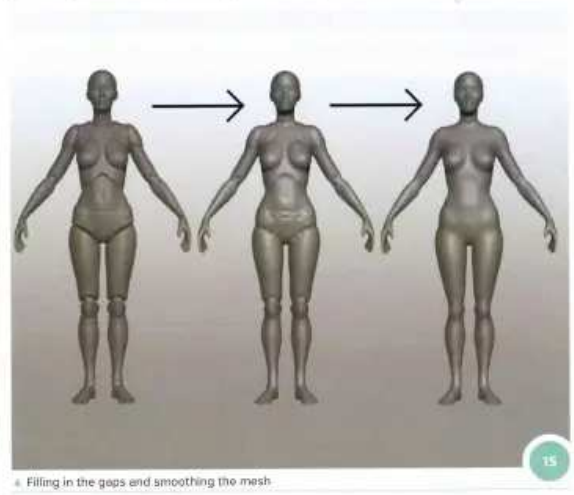
We should take a step back and check the proportions of the body; we don't want to find out too late that the proportions are wrong! An idealistic figure is eight heads in height. The arms are three heads long and the legs are four heads long. The shoulders of a female figure are about two heads away from one another. This is less than on a male body, due to the smaller rib cage on the female form. The widest part of the female body is the hips; the extra fat that females carry also adds to the width.

15: Combining the mesh

All parts should be in proportion now, so it's safe to combine everything into one mesh. To do so, just fill the gaps between the parts and smooth the surface.



▲ Make sure you check that the proportions match the ideal human frame



▲ Filling in the gaps and smoothing the mesh

16: Overview of the landmarks

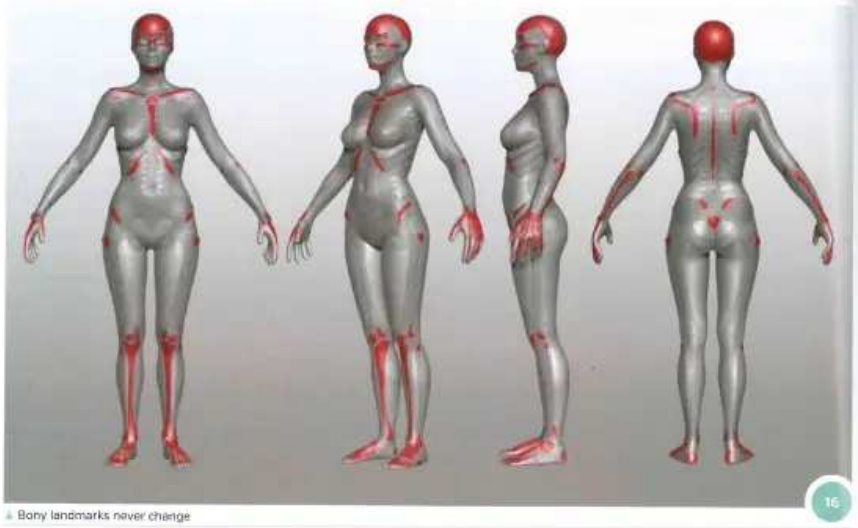
The whole body is made of soft versus hard forms. There is a constant transition between the hard bones and smoother materials such as flesh, muscle, and fat.

To show this interplay you need to place the bony landmarks of the body first. They are always visible on the surface of a figure no matter how much muscle volume or fat pads are developed. Knees and elbows, for example, always remain in their position, while other features of the body can grow bigger or thinner.

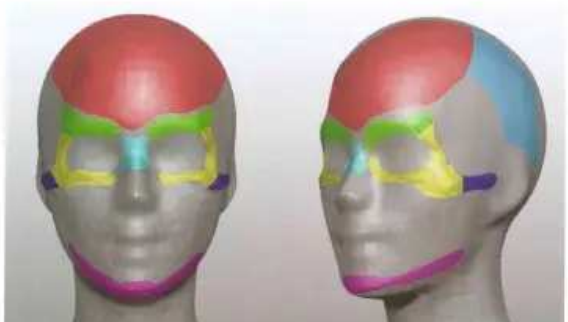
"The top of the skull and cheekbones are very prominent, and the eyes are bordered and protected by the bony eye sockets"

17: Bony landmarks – head

The majority of the head is bone, which means there are several important landmarks that we need to focus on here. The top of the skull and cheekbones are very prominent, and the eyes are bordered and protected by the bony eye sockets. The temporal line establishes a plane change to the upper part of the head.



▲ Bony landmarks never change

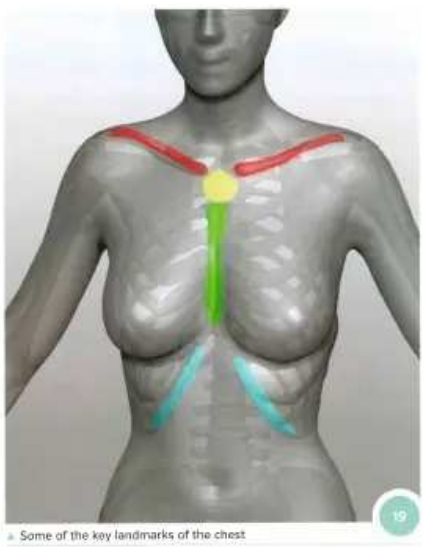


The top part of the nose is made up of nasal bone before it turns into cartilage and flesh. In the profile you can observe a plane change at this point.

18: Bony landmarks – upper back

The scapula is particularly visible on the upper back. It's a point of origin and insertion for many muscles; you will always see a bony line from the top of the shoulders, going down at a slight angle, towards the spine. The medial border almost falls down

▲ Pin-pointing the landmarks of the upper back



▲ Some of the key landmarks of the chest

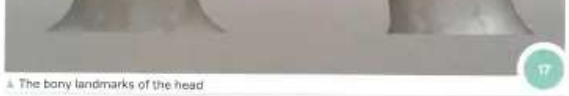
protrusion on the spine on the lower neck, known as the 7th vertebrae.

19: Bony landmarks – chest

The clavicles are shaped like a bow with the ends to each shoulder. They have an S-shaped curve as viewed from the front and top. At the middle they are connected to the manubrium. This is part of the sternum that goes down the chest. It falls steeper at first and flows to a smoother angle before it gets to the breast area. The lower border of the rib cage is called the costal margin.

20: Bony landmarks – pelvis

The iliac crest goes around the body and is most prominent at the front side where it is not overlaid by fat or muscles (fig.20a). The anterior superior iliac spines are starting points for many muscles of the legs and the upper body. On each side of the upper legs the greater trochanter of the femur leaves an indication on the surface, as it is exposed out of the hips to ensure free movement of the legs (fig.20b).



▲ The bony landmarks of the head

straight on either side of the spine.

Other landmarks include the acromion, a small square-shaped plateau located at the top of the shoulders, and a significant

▲ The key landmarks of the pelvis

▲ The greater trochanter of the femur is prominent

▲ Back view of the pelvic landmarks, where the lumbar vertebrae meets the sacrum

As the spine travels down to the pelvis you can see some bones of the lumbar vertebrae before it descends into the sacrum (fig.20c). On a female the indication on the surface is shaped like a rhombus formed by the muscles and landmarks surrounding it. Two deeper dimples show up on each side, the posterior superior iliac spines.

"From the olecranon to the lateral side of the hand you can see the crest of the ulna. It sits between muscles and becomes more prominent as they are activated"

21: Bony landmarks – arms

On the upper arm appear the landmarks of the humerus, the medial and lateral condyles. You can also see the head of the ulna or olecranon process – it's more or less on one line with the other two landmarks in this position. On more bony figures the head of the radius also shows up.

From the olecranon to the lateral side of the hand you can see the crest of the ulna. It sits between muscles and becomes more prominent as they are activated.

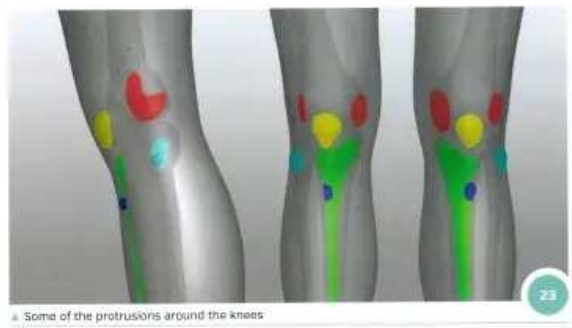
At the wrist the ulna ends in the styloid process; on the other side the styloid process of the radius sticks out quite a bit.

22: Bony landmarks – hands

Like the head and feet, the hands are very bony. From the wrist, they start with the carpals and metacarpals, developing into the phalanges of the fingers and thumb. There are mostly tendons and some muscles that sit

▲ Various protrusions caused by the radius and ulna

▲ Some key bones in the hands



▲ Some of the protrusions around the knees

on top of that bony structure. The palm side of the hand has a softer appearance created by fat and muscles.

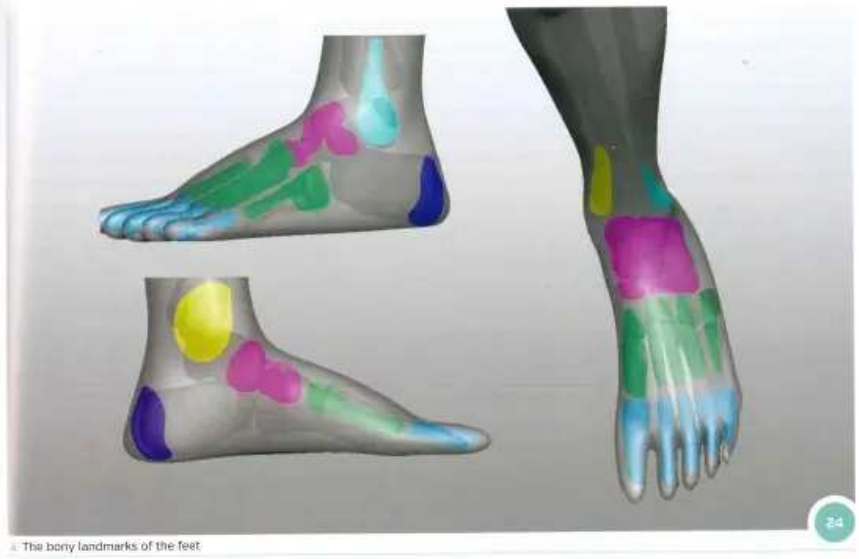
23: Bony landmarks – lower legs

The knees are a very detailed region when it comes to the bony and muscular structure. You can see the condyle of the femur on each side, just above the patella; this allows the leg to roll on the plateau of the tibia when bending the knee. As it rotates to the back, the gap between the bones is protected by the patella, which slides into position on a tendon. Not far down the tibia this tendon grabs on to the bony ridge of the tibia, the tibial tuberosity.

24: Bony landmarks – feet

Feet are made of bones on the top and very dense fat pads on the bottom, which carry the weight of the entire body. At the ankles you can see the end of the tibia (the medial malleolus), which is higher than the end of the fibula (the lateral malleolus). As with the hands, these forms progress from bigger bones to smaller ones. The back of the foot has an extra heel bone, the calcaneus. The outer side of the foot leaves a visible landmark on the surface; the tuberosity of the 5th metatarsal.

"Feet are made of bones on the top and very dense fat pads on the bottom, which carry the weight of the entire body"



▲ The bony landmarks of the feet

Sculpting an archetypal figure

3D female

Part 02 | Muscles

By Mario Anger

Animator

The bony landmarks and proportions of the female figure were established in part 01 so it's now time to start adding muscle groups to the body.

This part will use the skeletal structure as a guideline to affix muscles that have visible influence on the contours of the surface. Building the body up like this will show how single elements work together on different levels and form an overall cohesive mass.

After this, the volumes will be readjusted to fit the silhouette of the female body, before skin is added in part 03.

01: Muscles of the torso – anterior

The pectoralis major is the largest muscle in the chest area. It's separated into three sections, which insert onto different points of the outer side of the humerus. The muscle masses are twisted at the armpit, so that the lowest section goes into to the highest point and vice versa.

▲ Some of the major muscle groups on the front of the torso

The rectus abdominis muscles attach right under the pectoralis major, around the 5th and 6th ribs. They are more like a thin cover of muscles over the stomach separated into eight non-symmetrical sections than individual muscles. The "six-packs" follow lines that would start at both sides of the waist.

02: Muscles of the torso – lateral

The external obliques originate at the sheath of the rectus abdominis and the iliac crest. From there they shoot upwards to the rib cage; the lower part often overlaps the iliac crest of the pelvis. The top sections are usually rather thin.

At the lower ribs (8th and 9th) they begin to meet and grab onto the serratus anterior and insert into the underside of the scapula. The mass of this muscle creates small convex shapes on top of the obliques. On the back of the body it forms a plane change that seems to elongate the medial border of the scapula downwards.

03: Muscles of the back – superficial

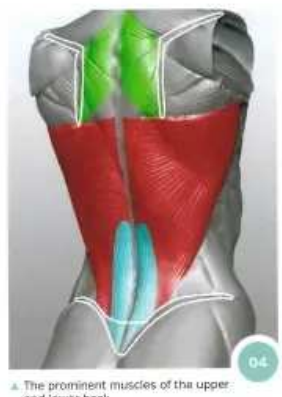
Many of the superficial (outermost) muscles lay over each other on the back to form a familiar surface.

On the spine of the scapula the trapezius has its starting edge. It attaches to the vertical line of the spine from the occipital bone to the last thoracic vertebrae. Where it meets the top corner of the scapula, it leaves a round notch under the surface. It flattens out when it reaches the 7th cervical vertebrae and exposes that bony structure.

The scapula gives also birth to an equally prominent muscle, the teres major. This lives between the inside of the humerus and the lower part of the scapula. Above that, in the void to the trapezius, sit two less distinctive muscles, the teres minor and the infraspinatus.

04: Muscles of the back – second layer

The rhomboid muscles sit underneath the trapezius. Both of the rhomboid muscles attach to the medial border of the scapula but only the edges are



▲ The prominent muscles of the upper and lower back

visible on the surface. More important to surface appearance is the latissimus dorsi, which originates on the iliac crest and along the edge of the lower lumbar and thoracic vertebrae and attaches at almost the same place as the teres major at the humerus.

The lower part on the back is less thick, so it creates a diagonal plane change. The erector spinae grab on the sacrum and go up like tubes close to the spine. They thin out more evenly when they pass the vertebrae.

05: The deltoids

The deltoid muscle is separated into three big segments: the anterior, the medial, and the posterior head. The anterior head starts at the lateral side of the clavicle

▲ The medial deltoid attaches to the acromion process

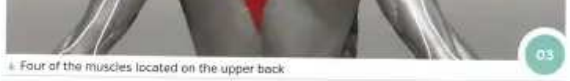
and leaves a small gap at the pectoralis major. The medial head of the deltoid is fixed on the acromion process (fig.05a). The posterior head has its origin at the spine of the scapula and, like all the other heads, it has its insertion half-way down the humerus on the outside (fig.05b).

06: Muscles of the upper arms – anterior

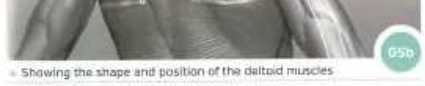
The biceps brachii originates from the scapula. It inserts into the layer under the deltoid and pectoralis major. It ends in two tendons; one attaches onto the radius and the bicipital aponeurosis covers and protects the brachial artery.

The biceps' main function is to support flexion (bending) of the elbow and supination (rotation) of the forearm.

▲ The external obliques and serratus anterior have a serrated appearance

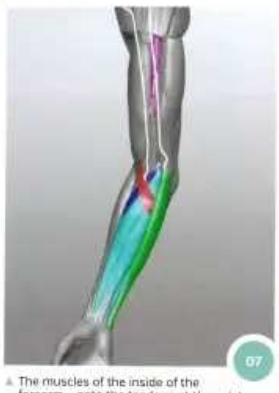


▲ Four of the muscles located on the upper back



▲ Showing the shape and position of the deltoid muscles

▲ Major muscles surrounding the humerus



▲ The muscles of the inside of the forearm – note the tendons at the wrist

▲ The muscles on the back of the upper arm

▲ The muscles of the outer side of the forearm

07: Muscles of the forearms – inner side

In this view the bicipital aponeurosis is most noticeable. Also, a muscle right under the armpit comes into sight, the coracobrachialis. It creates a small tube when the arm is raised.

From the medial epicondyle of the humerus, a common mass of muscles comes out and inserts into the palm side of the hand.

08: Muscles of the upper arms – posterior

These extensor muscles share a border with the crest of the ulna and the flexor carpi ulnaris of the lower arm. Together they create a clear indication of the ulna bone.

The triceps brachii on the upper arm consists of three heads and attaches to the olecranon process. The long head goes from the elbow to a high point of the scapula. The lateral and medial heads have their origin at the humerus. On the outside of the arm the muscle forms a very prominent egg shape that's caused by the fibers of the lateral head.

09: Muscles of the forearms – outer side

Starting at the lower half of the humerus, the brachioradialis and the extensor carpi radialis longus come out of the edge between the triceps and the brachialis. They create, more or less, a single mass and insert onto the thumb side of the wrist.

The extensor carpi radialis brevis has its origin at the lateral epicondyle and sits one layer under the extensor radialis brevis. Together they create a small depression on the surface at that point.

A group of extensors also originates at the lateral epicondyle and stretches across to the hand's dorsal side.

▲ Key muscles in the thighs

▲ Muscles of the back of the legs

10: Muscles of the legs – anterior

The anterior superior iliac spine is a starting point for several muscles.

The sartorius and the tensor fasciae latae both grab onto it. They spread out like an upside down "V" as they go down the leg. The sartorius is a long but very flat muscle. It goes past the knee in a curved path and inserts into the tibia.

The empty space of the "V" is filled by the quadriceps, which present three heads on the surface. The rectus femoris goes straight down the femur and turns into tendon before it inserts at the tibial tuberosity.

▲ Muscles making up the outer side of the legs

▲ The inner muscles of the leg

11: Muscles of the legs – posterior

On the back of the legs lives a bundle of muscles that can be called the hamstrings. They are more or less one big mass at the top, which spreads out in the lower half into the right and left. The inner side has a somewhat lower insertion.

The back of the lower legs are covered by the calf muscles, assembled by the soleus and gastrocnemius. The shape starts as two columns from the epicondyles of the femur. Its inner (medial) side goes lower than the outer (lateral) one. Both muscles grab onto the Achilles tendon that is fixed to the heel bone.

▲ Muscles comprising the inner shape of the foot

12: Muscles of the legs – lateral

The tensor fasciae latae goes into a fascia on the side, the iliotibial band, which is connected to the tibia. The gluteus muscle spreads out like a wheel from the greater trochanter and leaves a depression in the middle. It inserts onto the sacrum and the iliac crest.

On the lateral (outer) side of the tibia starts the tibialis anterior. It crosses the shin bone and grabs onto the medial (inner) side of the foot. It has its biggest mass on the upper half and creates quite a big shape on the surface in this region.

13: Muscles of the legs – medial

The triangle shape above the sartorius is filled in with adductor muscles that insert at the pubic bone. These powerful muscles pull the leg away from the midline of the body.

The gap between the tibia and the soleus is filled mostly by a muscle called the flexor digitorum longus. It goes behind the medial malleolus and grabs onto the foot.

14: Muscles of the foot – medial

The abductor hallucis goes from the first metatarsal of the big toe to the border of the calcaneus. It fills in the void that is caused by the arch of bones; fat pads on the bottom of the foot also pad out this void.

Above that are the bony structures and tendons of the lower leg muscles that grab onto the bones of the foot.

15: Muscles of the foot – lateral

The abductor digiti minimi goes from the smallest toe to the calcaneus. This outer border of the foot connects it with the ground. Note that the foot touches the floor only with the heel, toes, and outer side.

The extensor tendons of the digitorum longus create some visible shape on the upper side as they proceed toward the phalanges.

16: Muscles of the hands – palmar side

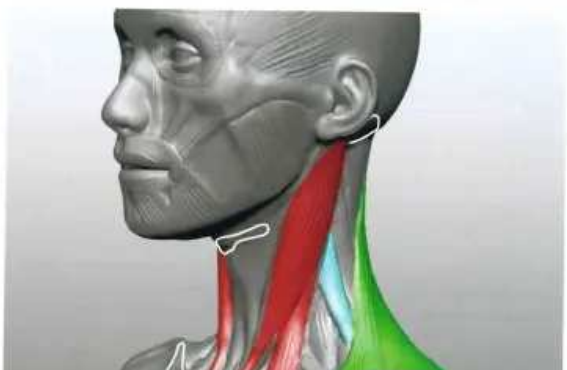
On the thumb side are the round muscle masses of the thenar eminence. On the outer side they are called muscles of the hypothenar eminence.

In the middle of the palm are flexor tendons going to the phalanges; these can pop out on the surface.

▲ The extensor tendons make the distinctive forms of the foot

▲ The hand's major muscles for movement and contours

▲ Muscle masses on the surface of the hand and wrist



17: Muscles of the hands – dorsal side

The first dorsal interosseous muscle sits between the thumb and the first index finger. It creates a nice convex shape on the surface.

The extensor pollicis longus and the two tendons of the abductor pollicis

18: Muscles of the neck – lateral

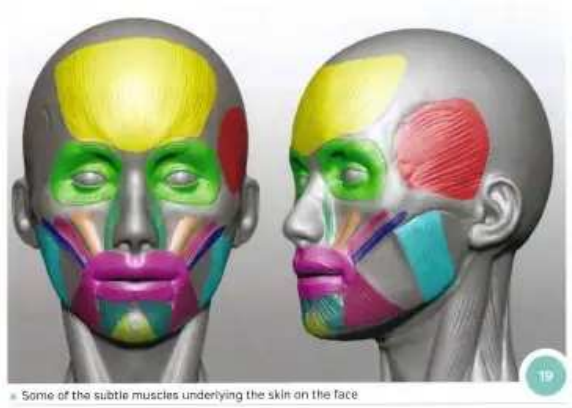
A lot of the shape of the neck comes from a muscle called the sternocleidomastoid. It has two origins, the clavicles and the sternum, and ends at the mastoid process on the head.

Between the sternocleidomastoid and the trapezius, only a few muscles actually create surface forms. One of them is the levator scapula, which comes from the spine and the border of the rhomboid. The hyoid bone and cartilage below create the profile of the neck.

19: Muscles of the face

The muscles of the face are not particularly thick, however, the masseter and temporalis are perhaps the most visible. They lie flat under the skin and bunch together to create the multitude of expressions we make every day. When they pull on their insertions, they fold the skin perpendicular to their direction of movement.

Little protrusions appear at the corners of the mouth, which are caused by muscles that insert there and pull back.



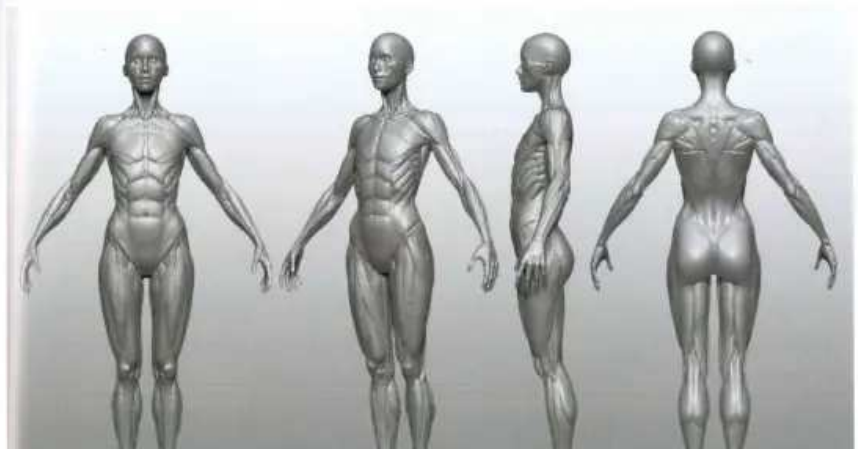
▲ Some of the subtle muscles underlying the skin on the face

20: Adjustments

Now that we have added all the muscles on to our model it is vital to create a convincing surface form and general silhouette.

So, before the skin is added, adjustments need to be made by smoothing out any rough or lumpy edges, such as the shoulders and stomach. Also, if necessary reduce and blend the muscles together to create a softer silhouette and make it less bulky and more feminine.

It's good to have every muscle placed for the underlying structure, but remember that they will flatten out in further processes.



▲ Defining the shape of the neck

18

longus and extender pollicis brevis create a depression between them.

On the wrist, the tendons are smoothed out by the dorsal carpal ligament.

▲ The muscular form, ready for skin and detail

20

Sculpting an archetypal figure

3D female

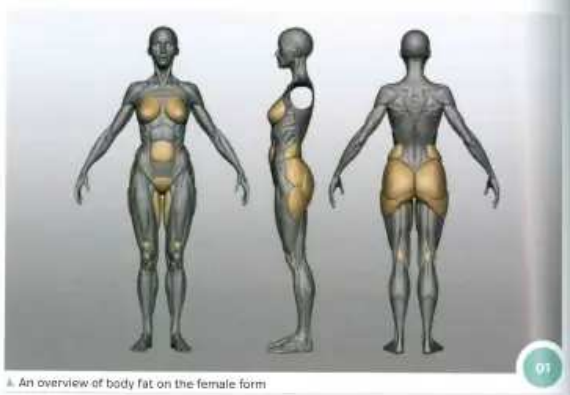
Part 03 | Body fat and skin

By Mario Anger

Animator

After parts 01 and 02, the body is almost complete, so it's time to start refining the overall shape by adding skin and features of the specific body type. This part will introduce body fat as shape-altering masses and also show how to refine the hands, feet, and face to create a more natural look. The final figure will be showcased to create a portrait shown under different lighting scenarios. At the end there will be a generic female figure that can be used as the base model for character implementation.

"Body fat, in particular, alters the appearance. The silhouettes of men and women differ greatly because the distribution of fat is different"



▲ An overview of body fat on the female form

01

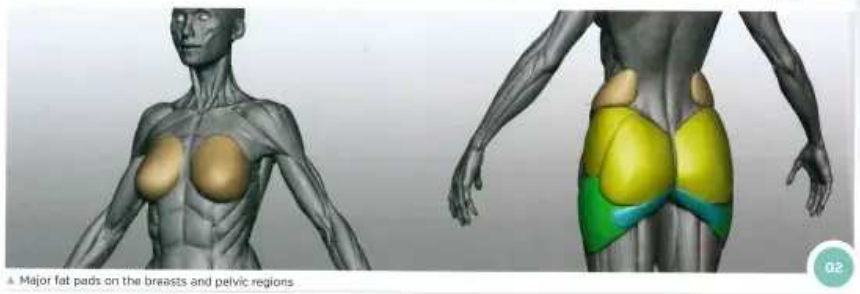
01: Body fat – an overview

The body, of course, does not consist solely of bones and muscles; there are other materials that influence the shapes and contours of the surface as well. Body fat, in particular, alters the appearance. The silhouettes of men and women differ greatly because the distribution of fat is different.

Generally, the fat in women's bodies makes up a bigger percentage of the total body mass. On top of the muscles, fat softens the structure and fades parts together, so areas like this need to be sculpted with a soft feeling to it.

02: Body fat – breasts and pelvis

The breasts are one of the major parts on the female figure that are mostly composed of fat. The pelvic region is also made up of different pads that blend together nicely. They build up a soft transition from the hips to the legs and blur the indications of underlying muscles.



▲ Major fat pads on the breasts and pelvic regions

02

They also intensify the illusion of higher hips, because the waistline starts earlier. On the back they soften out the mass of the gluteus maximus at the bottom.

03: Body fat – stomach, rear legs, knees, hands, and feet

In fig.03 you can see the protrusion of the abdominal fat pad. This creates a noticeable horizontal line and a plane change right under the belly button when it is well developed.

On the legs, the space between the hamstring muscles is filled with popliteal fat that smooths out that region around the kneecap. Above and under the knee sits fat that can create considerable bulges on the surface.

The inner sides of the hands and the under sides of the feet also have fat pads that create a softer look on the surface.

04: Setting up planes – an overview

After combining all major elements of the body to one unified mesh, it's a good idea to establish the important plane changes and transitions on the surface; we do this to ensure a natural and realistic model.

Muscles overlay bones and each other, and the surface is often affected in a way that means you're unable to identify exactly where a specific bump is coming from. It's better to exaggerate edges first and tone them down later on areas where they should not be that prominent.

05: Setting up planes – upper body and hands

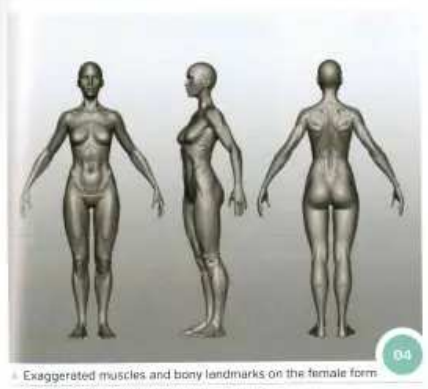
On the upper body, the rib cage creates a significant change of angles on the costal margin. There is a visible line where the manubrium is connected to the body of the sternum.

The mass of the rectus abdominis works down from the bottom of the ribs and they create their own border planes which slightly separates it from the rest of the stomach.

Around the sides, the oblique is not that thick at the top, so it changes planes further down to the iliac crest. The arms don't go straight into the hands. In fact they change angles at the styloid process.

▲ Some of the key fat pads located on the abdomen and limbs

03



▲ Exaggerated muscles and bony landmarks on the female form

04

▲ Key planes shown on the upper body

05

06: Setting up planes – back

On the back, the posterior head of the deltoid loses its convexity before it attaches to the spine of the scapula. The teres majors are very prominent muscles that stick out of the surface a lot.

The trapezius shows separation in its volume, and is made of lower, upper, and middle fibers. As the latissimus turns into tendon on the lower half, it creates a fold on the surface.

07: Setting up planes – face (anterior)

The surface of the face can be separated into several planes caused by bony protrusions, muscles, and fat pads. The temporal line cuts off the sphere-like volume of the skull by creating a more angular shape on either side of the head.

Three major planes create the forehead with slightly different angles. At the edge of the supraorbital foramen above the eyes, a diagonal plane change occurs that pushes out the bone of the eye socket around the eyebrow (supraorbital margin).

The front of the face can be separated from the side on a line from the zygomatic bone to the tip of the chin.

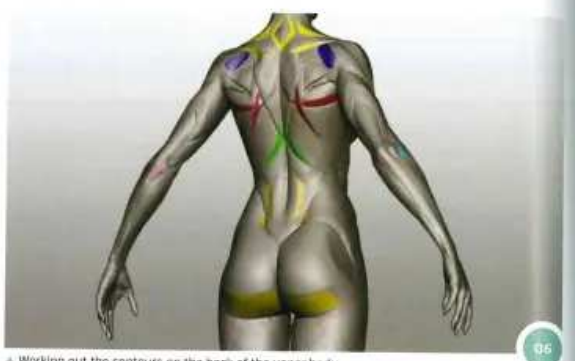
08: Setting up planes – face (3/4 and profile)

Muscles of the chin create a deep indentation when they touch the edge of the orbicularis oris (lip muscles), which encircles the mouth; this greatly affects the look of the face when in profile.

The plane change formed by the zygomatic bone and the fat pads at the side of the nose creates a diagonal line down from the caruncula lacrimalis (tear duct); most of this is usually covered by a fat pad.

09: Face – ears

The ears sit on top of the external



▲ Working out the contours on the back of the upper body

06

▲ Creating the more intricate contours of the face

07

▲ Subtle plane changes in the side of the face

08

and helix form one tube that starts in the middle of the ear, goes to the upper edge, and surrounds the ear until it reaches the lobule on the lower end.

A second curve is positioned right inside that border, the antihelix. The protrusions of the tragus and antitragus face each other on opposite sites.

▲ Key shapes in the curves of the ear

09

10: Face – eyes

The eyeballs are covered by two thin ribbons of muscle and skin, which act as a protective barrier against foreign debris and keep the eye from drying out.

11: Face – nose

The bridge of the nose comes down from

▲ Keep the eyelids curved, rather than flat lines

10

▲ The various shapes and contours of the nose

11

The apex or tip is often slightly bulbous in shape and the transition between the tip and the columella (the column that separates the two nostrils) can be quite steep.

Finally, the alar or wings are curved cartilaginous material, which attach to the sides of the tip; they form the external nares (nostrils).

▲ Creating convincing bulges in the lips

12

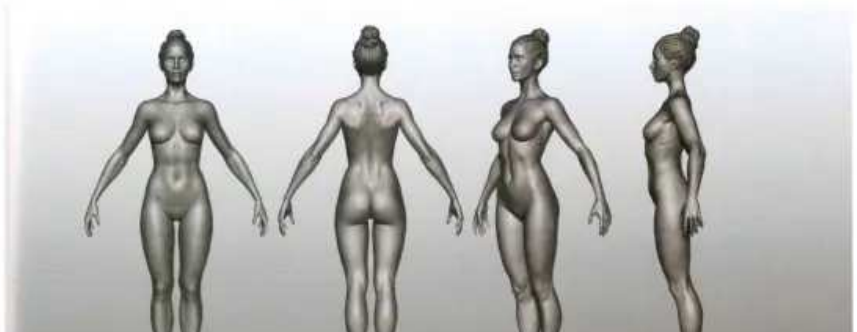
12: Face – lips

The upper and lower lips are made from different shapes. The lower lip is made up of two segments that meet in the middle. The upper lip has an additional segment (Cupid's bow) between the two sides; it has two peaks which become the philtrum at the base of the nose. This is usually more pronounced in females. On each corner the lips are rolled into the mouth and establish a triangle shape in the outer corners.

"Remember that the skin will bunch up and crease, or form wrinkles, at specific points where it is stretches, bends, or moves"

13: Skin

The skin brings all the forms together. It creates transitions from bone to muscles to fat; think of it as a tight suit that covers the inner structure. Remember that the skin will bunch up and crease, or form wrinkles, at specific points where it is stretches, bends, or moves in different directions.



auditory meatus – the ear canal that goes into the skull.

The shapes of cartilage and flesh can be made out of curved tubes. The concha

The borders of the lids are curved and not flat lines. The upper eyelid is layered over the lower lid and overlaps most prominently at the outer side of the eye.

forehead and is formed of nasal bones. The septum forms a connection between the bridge and apex; it breaks up the angle of the bridge as the transition from bone to cartilage changes the planes.

▲ The full skin

14: Hair

Simple hair can be established in three consecutive steps. First, define bigger clumps that follow one direction. Secondly, add strands occasionally that mimic these paths. Lastly, create some lonely strands that break up that pattern.

15: Hands – palmar side

On the hands the constant change of bone and soft material is quite visible. The tendons and muscles lie right next to each other and create many edges and plane changes. You'll notice that curved folds appear on the surface of the palm side due to the bending of the fingers and thumb.

16: Hands – dorsal side

Phalanges are divided into three segments; the thumb is divided into two (fig.16a). On the dorsal side of the hand the first segment in each of the fingers is the longest. The second one is just half as long and the tip is the shortest.

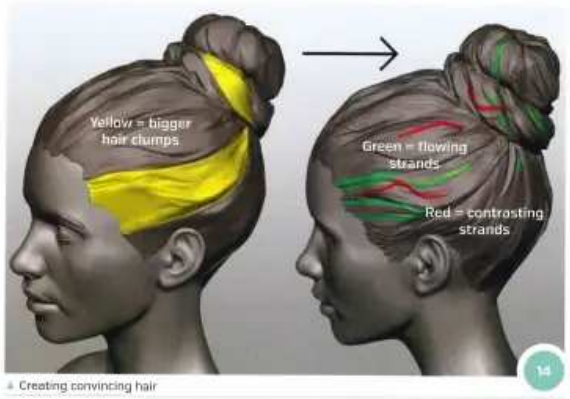
> "You'll notice that curved folds appear on the surface of the palm side due to the bending of the fingers and thumb"

On the palm side, however, the segments are almost the same length and all three together are slightly shorter. From the side view of one finger, the first two segments are more or less in one line. The last one can be shifted inwards to create a more natural look (fig.16b).

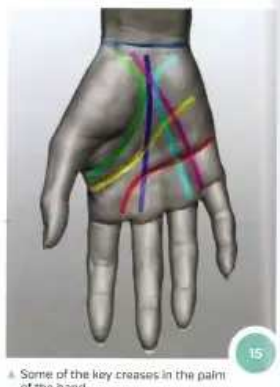
Fingernails sit on top of the fingertips. They are nearly flat planes that are pushed in towards the finger just a tad.

17: Feet

Like the hand, the phalanges of the foot are divided into three segments and only the big toe possesses just the two. Also, the tip of each toe is pushed inwards a little with a flatter plane on the top for the nails. From the side view, the four smaller toes seem

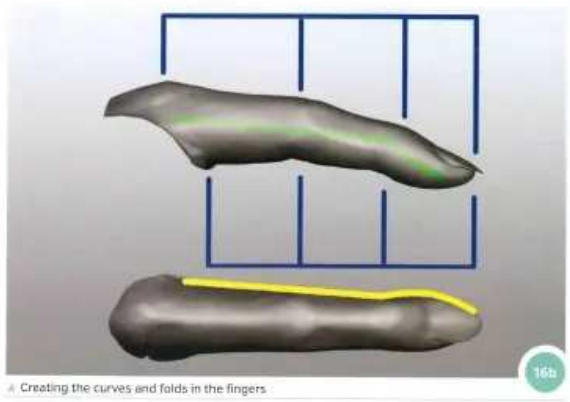


▲ Creating convincing hair

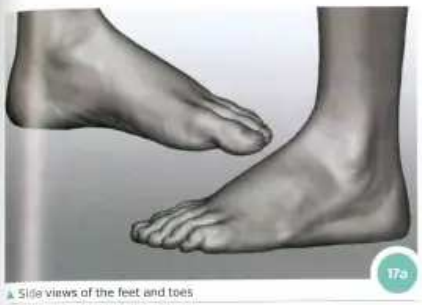


▲ Some of the key creases in the palm of the hand

▲ The fingers have three knuckles but the thumb only has two



▲ Creating the curves and folds in the fingers



▲ Side views of the feet and toes

▲ Posterior and top views of the feet and toes

to grab into the floor, while the big toe lies almost flat on the ground.

The abductor hallucis and the abductor digiti minimi create a convex mass before the foot touches the ground (fig.17a, fig.17b).

18: Veins

Veins are vulnerable constructs of the body, that's why they are mostly placed on the inner sides of arms and legs. They can be formed like tubes on the surface. For a realistic look they should dive in and out under the skin (fig.18a).

On a female body they are almost toned down to an invisible level, but can still be seen under some special lighting circumstances (fig.18b).

▲ Veins should dive in and out under the skin

▲ Prominent veins ready to be toned down

19: Lighting setup

If you want to check the shapes of the figure, it's a good idea to render it out in a studio surrounding.

This basically means that you have to create a ground floor which is curved up as it diverges from the camera. That way you'll get a smoother transition between shadow and light on the floor.

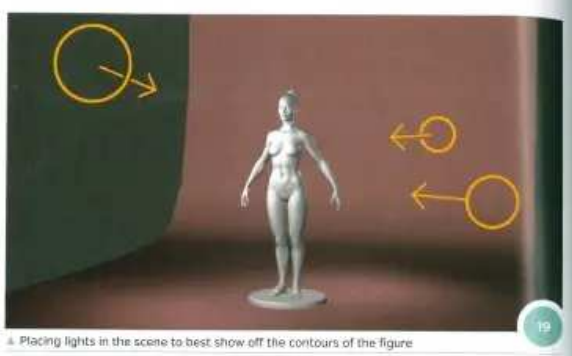
You can work with two or three lights to illuminate the scene. The main light should be the strongest, as it shines directly upon the object. Another spot from the side fills in the shadows with some information of shape. If desired, you could also add a back light that illuminates the figure from behind in order to better separate the object from the background.

20: Renders

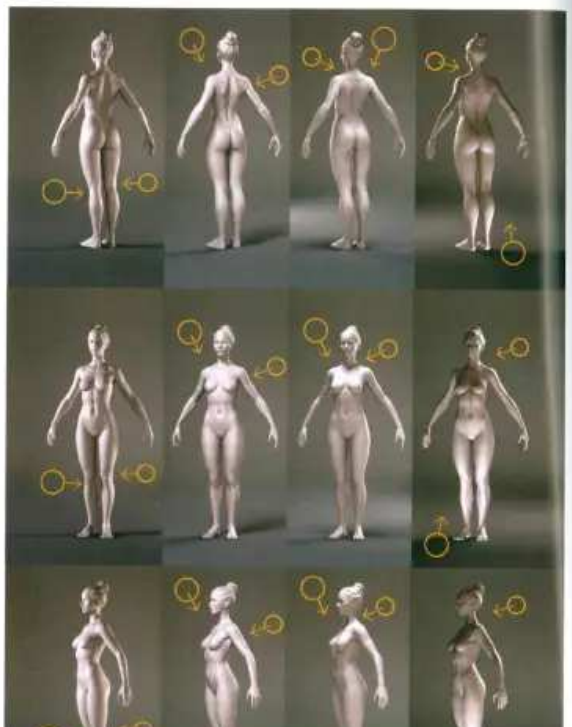
To get a good idea of how well the surface is working, you should change the light positions while rendering as much as possible. In comparing the results of extreme angles (a key light from the top or bottom, for example), you can make out some huge differences between how shapes look on the surface.

PROTIP
Rendering your figure

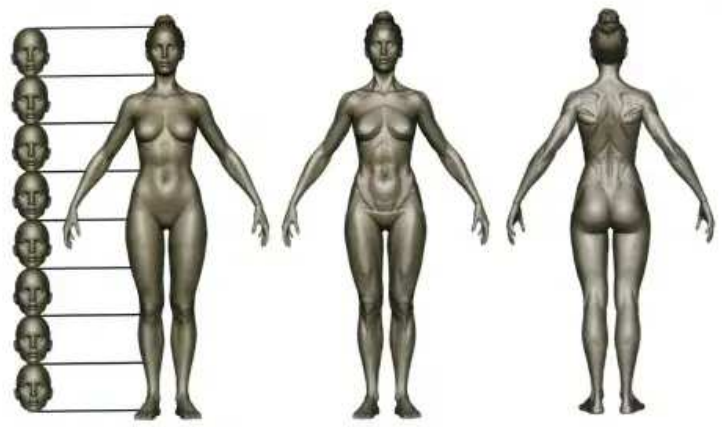
To render out your 3D figure under realistic conditions you can use a standalone real-time renderer like Marmoset Toolbag or KeyShot. They use physically accurate cameras and lights to calculate the final image. Simply import the model as an OBJ file, use any environment, choose a material for the model, and hit the render button.



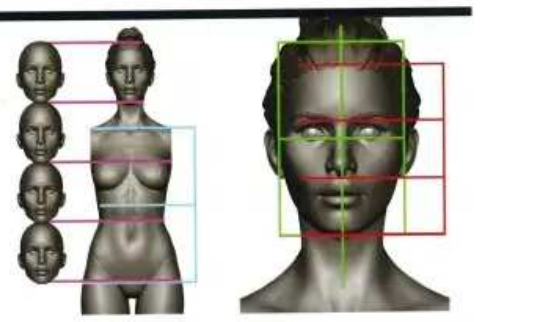
▲ Placing lights in the scene to best show off the contours of the figure



21: Proportion reference chart



> "It is a good idea to frequently refer to observation of human bodies, whether this is looking at a real human or a photo"



As a final aid for you, fig.21 provides a reference chart to illustrate the various proportions we've encountered in the female body, as well as some additional planar images for reference.

▲ Testing out different lighting conditions to fully accentuate certain areas

▲ You need to ensure you use the correct proportions to get a realistic-looking model

Sculpting an archetypal figure

Advanced 3D female

Part 01 | Face and neck

By Mario Anger

Animator

Now that the female figure is established in its morphological (form) and anatomical (construction) structure, it's time to take a closer look at particular parts and their range of movement.

In this part we will focus on the face and neck and show how these body parts are posed in conjunction with one another. Later on, we'll look at single elements like the eyes and mouth. We'll discuss how they can be portrayed in different extremes to convey a feeling and how the muscles can alter their shape. Finally, the expressions of the face will be examined further and we'll describe how the interplay of underlying facial muscles creates a coherent look on the surface.

01: Lateral bending of the neck

The head is rotated, flexed, extended, and bent by the muscles of the neck. When the ear leans toward the shoulder while looking straight ahead it's called lateral flexion.

▲ Locating the muscles on the neck during lateral bending

▲ Some of the muscles involved in lateral flexing of the neck

▲ Side view of lateral flexion

▲ Turning the head reveals new contours around the neck

In the average person, the head is able to bend halfway between the midline of the body and the position of the shoulder. The muscles are activated on this side of the head where the ear leans towards the shoulder. They become thicker because their anchor points are moved towards each other. On the other side, muscles are stretched and thin out. Towards the clavicles you can even spot tendons on the surface.

02: Muscles in the lateral bend

In fig.02a and fig.02b you can see the extent to which muscles can thin out or thicken when they pull on their anchor points. Bending the head is a functional interaction of muscles that grab mostly on the mastoid process and the occipital bone of the head. The muscles, on the side of the neck which is bending, move closer to their insertion points at the clavicle, scapula, or acromion.

▲ Identifying the prominent muscles on the neck

03: Rotating the neck

The neck is able to turn the head to the right and the left quite a bit. Its maximum range is about 80 degrees so that the chin is almost pointing to the shoulders. Muscles rotate the neck and head around the longitudinal axis of the cervical vertebrae (neck bones of the spine). This axis inserts at a joint below the skull, from a side view somehow in line with the external acoustic meatus.

There is more than one muscle in the neck which is responsible for rotating or turning the neck. However, we are only interested in the surface muscles because they affect the silhouette. On the surface the sternocleidomastoid is the most prominent one (fig.03b). It tries to shorten the distance between the mastoid process and its insertion points at the sternum and clavicle on one side of the head. At this region two tendons pop out right under the skin. A more convex round mass becomes visible at the upper part towards the head.

PRO TIP

Flexion and extension

Remember that the body is able to perform two types of angular movement, which effects the angles between two body parts.

Flexion is the act of bending of a body part, this reduces the angle. **Extension** is the opposite and increases the angle. For example, when the arm bends at the elbow it is flexing and when it is straightened out it is extending.

04: The neck: extension and flexion

Extension is tilting the head back (fig.04a). The eyes are able to look straight up in this extreme pose, which is a 70-degree bend from the midline of the body. The head is moved back right below the skull by the bones of the cervical vertebrae, which act like a bent chain.

The extension stretches and flares out the muscles below the chin. It also shortens and thickens the muscles on the back of the neck such as the trapezius or splenius capitis, coming from the upper back of the torso (fig.04b).

The anterior fibers of the sternocleidomastoid give an additional pull to the rear part of the head. Beneath the hyoid bone the two protrusions of the cricoid and thyroid cartilage show up on the surface quite prominently; this is less prominent in females.

Bending the joints of the cervical vertebrae towards the chest is called flexion (fig.04c). The angle relative to the midline of the body decreases. Normally the chin is able to touch the chest. So the change of angle is something like 60 degrees maximum. While flexing, the neck muscles are almost reversed. The back muscles of the neck are relaxed and stretched, the front muscles are active. The posterior fibers of the sternocleidomastoid have a small influence too (fig.04d).

▲ Extension of the neck

▲ The muscles involved in extending of the neck

05: Muscles of the face

When muscles beneath the skin of the face are activated in certain relation to each other, they create expressions. As a part of nonverbal communication, they help to transfer information between humans.

Facial muscles are different to skeletal muscles; they originate near the bone and don't create any considerable shapes on the surface. Think of it being like a fine mask on top of the skull, and subtle folds that occur when muscles pull skin together are important for reading countenance.

The neutral position is the base of all expressions. To identify an emotion, the brain puts it in relation to this muscle setup (fig.05a, fig.05b).

▲ Neutral facial expression

Flexion of the neck

The muscles responsible for flexing the neck

The neutral expression is the default base for all expressions

PROTIP

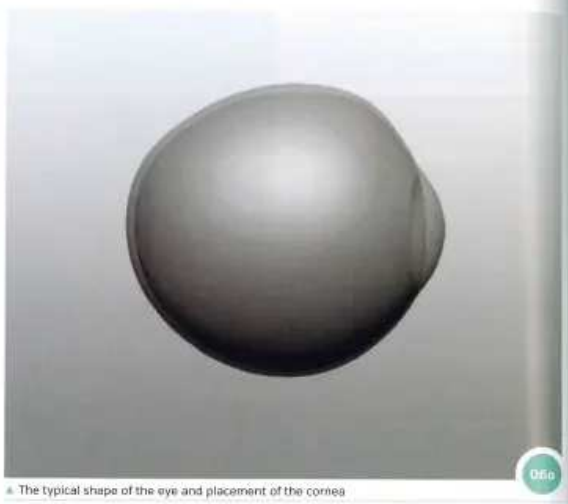
Blend Shapes

To check if poses and expressions work correctly you can use Blend Shapes. Transfer the mesh to a different application like Maya or just create an extra layer for each pose you are sculpting. Sliding it on and off between poses will blend smoothly. A little movement always tells more than a static picture or pose.

06: Deformation of the eyes

The eyes are not just simple balls sitting in the eye sockets. They are imperfectly-shaped or rugby-ball-shaped spheres that can appear shorter or longer from the side view. At the front they become flatter where they are surrounded by eyelids. In the middle of the shape, a small tip sticks out – this is the cornea (fig.06a). When the eyes rotate, this protrusion moves under the skin, so it actually creates a convex plane change on the surface.

When rolling to the sides or up and down, the eyebrows most often follow the movement to clear the sight path for the eyes (fig.06b).



The typical shape of the eye and placement of the cornea

The eyebrows help move the skin around the eye

07: Deformation of the mouth

The muscles surrounding the mouth are able to create a rich assortment of poses and expressions, as you can see from the images in fig.07. The orbicularis oris contracts or widens the opening. It also can pucker the lips.

The muscles attaching to this circular shape create additional expressions. The jaw bone opens or closes the whole system with the help of the masseter muscles.

A big flat superficial muscle that was not mentioned before, the platysma, is connected to the mouth area on the sides and the bottom of the chin. It can help to depress the jaw or pull down the lower lip or angle of the mouth.

A variety of expressions of the mouth

PROTIP

Folds and wrinkles

To create folds and wrinkles in ZBrush you can use a sharp brush with a crisp alpha. The Dam_Standard brush gives good results. The Pinch brush then helps to increase the sharpness of the furrow lines. If that's still not enough you can use a Cavity mask to mask just the wrinkles and extrude the flesh around them with the Inflate brush.

08: Facial expressions – happiness

Pre-eminent US psychologist Paul Ekman (**www.paulekman.com**) created a whole "atlas of emotion" – a set of thousands of expressions that a face could potentially display. In simple terms, these can be broken down into a model of six basic emotions: disgust, happiness, anger, fear, surprise, and sadness. Sometimes contempt joins in as well. We will look at a few of these now.

Happiness (or smiling) for example has its active areas around the mouth and eyes, though eyebrows can also emphasize this range of emotion. "Crow's feet" wrinkles appear when the ring muscle that orbits the eye contracts (fig.08a).

The zygomaticus major and the orbicularis oculi primarily create a happy face (fig.08b). The lower lid of the eyes is pushed up to create a smiling eye. The corners of the mouth are pulled back and up so that the upper row of teeth begins to show itself.

The space between the eyes and mouth is compressed so that the cheeks are pushed up and become convex; with the contraction of muscles, folds can appear not only around the eyes and mouth, but sometimes even on the cheeks.

09: Facial expressions – shock, fear

Shock, fear or surprise usually generate a wide open expression. Fear forces the eyes open with raised upper eyelids and a tension in the lower eyelids. This can cause wrinkles in that area. In fear, the eyebrows are also raised and pulled together a little. Lips start to retract and get slightly stretched horizontally back to the ears. Sometimes the jaw begins to fall and the mouth opens (fig.09a).

On the forehead, the frontalis muscle

A smiling face actively uses mouth and eye muscles

downwards caused by the depressor anguli oris and the platysma muscle. This muscle is often activated with negative emotions like fear or fright.

10: Facial expressions – anger

Anger is expressed with the eyes, nose, and mouth. The eyes are wide open and glaring, nostrils are raised, and lips

A fearful expression pulls the muscles of the face back

The underlying muscles used in expressing shock or fear

become compressed or pulled down. Deep folds can appear around the nose if it is wrinkled. Again, eyebrows help to express the extremity of the expression by bulging towards to the middle (fig.10a). The corrugator muscle is responsible for the clenched and bunched up eyebrows. It also creates the wrinkled frown lines on the forehead.

Meanwhile the levator palpebrae superioris raises the upper eyelid. As a result, the space between the eyebrow and eye seams to get smaller.

The lifting of the upper lip by the levator labii superioris reveals the teeth as a sign of aggression. In addition, the orbicularis oris, which surrounds the mouth, tenses so that the lips become tight. The corners of the mouth are also pulled down (fig.10b).

raises the eyebrows. It also creates folds on the forehead (fig.09a). The cheek area flares out a little when the opened jaw stretches muscles between the mouth and eyes. The wrinkles of the mouth are pulled back and

08b

▲ Highlighting some of the muscles used in smiling

10a

▲ Expressing anger uses muscles of the whole face

10b

▲ The contraction of underlying muscles forms the expression

Sculpting an archetypal figure

Advanced 3D female

Part 02 | Shoulders, arms, and hands

By Mario Anger

Animator

In this part we will be looking at the shoulders, arms, and hands arranged in different poses. The range of movement of these body parts will be outlined in detail, along with the how the rotation of joints alters the skin surface and how active and passive muscles behave under these circumstances. The bony landmarks of the female figure should be used to keep the proportions consistent.

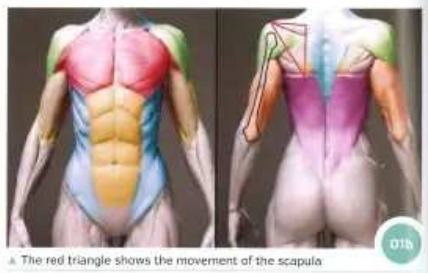
01: Shoulders and arms – relaxed

When shoulders move, the whole shoulder girdle is involved, so the clavicles, acromion, and scapula change in terms of rotation and position. The shoulders are able to move using rotation, elevation, and depression. Flexion, extension, abduction, and adduction can be added, if you count in the motion of the arms as well. Here, the arms hanging straight down on each side is the position with zero movement, and therefore the resting position (fig.01a).

The scapula rotates around the axis of its spine, the acromion, and the meeting point with the medial border. It moves relative to the humerus in the scapulohumeral rhythm. This movement can be explained in two stages. The first stage is the 0–30 degree abduction of the arm; the scapula rests in place while the humerus rotates. In the second stage the humerus moves from 30 to almost 180 degrees. The scapula acts in a 1:2 ratio, so it rotates 1 degree every 2 degrees of the humeral rotation (fig.01b).

01a

▲ Front and back view of the shoulders in a relaxed position



01b

▲ The red triangle shows the movement of the scapula

02: Shoulders and arms – abducted 90 degrees

Abducting, or lifting, the arms away from the midline of the body by 90 degrees causes the clavicles to show some movement. The clavicles are shaped like a long "S"; they show a convex curve on the surface facing upwards if they are rotated back. They become elevated on the sternum, but also rotate back around themselves along the axis from acromion to sternum (fig.02a).

02a

▲ The clavicles' position in relation to the sternum and acromion

02b

▲ The deltoid bulges when the arms are raised

03a

▲ The scapula is at its maximum rotation of 75 degrees

03b

▲ There are quite a few muscles which support this movement

PROTIP

Adduction and abduction

Adduction and abduction are movements which bring a body part either towards or away from (respectively) the midline of the body. For example, splaying the fingers is **abducting** and bringing them back together is **adducting**.

The rotation caused by this complete abduction of the arms brings their underside to the front. This allows for a greater range of movement; otherwise it isn't possible to abduct the arms much more than 90 degrees and therefore we wouldn't be able to reach up.

Also, the shape of the pectoralis major changes when the arms are raised; it stretches and flattens out a little. The insertion points on the humerus gradually reverse and cause this muscle to appear twisted. The lateral deltoid thickens as it is mainly involved in that abductive motion (fig.02b).

The infraspinatus and supraspinatus muscles take part in this movement as well, however they don't really show on the surface. They are fixed to the scapula but also pull on the head of the humerus to initiate abduction and it is completed by the trapezius pulling on the scapula. The spine of the scapula is rotated 30 degrees because of the scapulohumeral rhythm.

03: Shoulders and arms – abducted 180 degrees

By further abducting the arms to 180 degrees, you can see more of the frontal deltoid because it rotates around itself. The acromion faces backwards. The scapula is elevated to a maximum angle of around 75 degrees (fig.03a). Its lower end pushes outwards to each side of the body and creates a recognizable silhouette. Also, the clavicles are completely lifted and rotated, so their curved shape becomes very convex. The pectoralis major becomes stretched and flattens out to its maximum size.

Muscles like the latissimus dorsi, teres major, and rhomboid become thinner and relax because their insertion points move away from each other (fig.03b). The deltoid and trapezius contract and become thick. The opposite movement is when the arms adduct back to the sides, the latissimus dorsi contracts, and the deltoid and trapezius relax.

04a

▲ The elbow's bony landmarks form a horizon line in the extended position

04b

▲ The main muscle involved in elbow extension is the triceps brachii

04: Elbow – extension and flexion

When the arms are in their resting position (extension), the three bony landmarks of the elbow – the olecranon and the lateral and medial epicondyles – are more or less in a horizontal line (fig.04a).

There is only one major muscle involved with elbow extension and that is the triceps brachii (fig.04b). It brings

the forearm back to its resting place by the sides by becoming shorter and thicker, due to contraction.

The opposite of elbow extension is elbow flexion and this occurs when the forearm bends towards the shoulder. The three landmarks form a triangle with the olecranon becoming more pronounced and pointed; it rotates around the axis between the epicondyles (fig.04c).

The biceps brachii, brachioradialis, and brachialis are the muscles responsible for flexing the elbow; these anterior muscles increase their volume and foreshorten (fig.04d). The maximum angle of active flexion is approximately 145 degrees and it is limited by the volumes of the lower and upper arm as they will touch each other at some point.

"For the purposes of this project we will be focusing on the visible surface muscles, such as the extensor carpi radialis longus and the brachioradialis"

05: Lower arm – pronation and supination

When the elbow is flexed, the forearms can perform two different movements, pronation (fig.05a) and supination (fig.05b; see the pro tip box on the next page).

The bones of the lower arm are specifically curved in shape; this allows the radius to rotate around the ulna. When the forearms are in a neutral position the thumb faces up.

Some of the muscles responsible for both pronation and supination are deep within the forearms and therefore don't affect the silhouette. For the purposes of this project we

04c

▲ The three landmarks of the elbow

04d

▲ The triceps and biceps during flexion

05a

▲ Pronation with the palm facing down

05b

▲ Supination is when the palm is flipped to face upwards

05c

▲ The surface muscles twist with pronation

06

▲ Two views of the relaxed hand

07

▲ Two views of the spread hand

PROTIP

Pronation and supination

Pronation describes the position when the palm is face-down; supination is the opposite, when the palm is face-up.

06: Hands – relaxed

The hands can perform several different movements by rotating around their axes. They can extend or flex by rotating up or down and also bend to the side of the ulna (ulnar deviation) or the radius (radial deviation). When the hand is in a relaxed pose the flexor tendons and palm muscles are activated. This causes the palm to mimic the shape of a half sphere or vault.

07: Hands – spread

The fingers don't have muscles of their own and have to use the arm and hand muscles to enable them to extend, flex, and spread apart. The thumb also has enough mobility to reach/touch each of the fingers.

If the hand is over-stretched, the extensor tendons of the forearms (which attach to the phalanges) show up prominently on the dorsal view of the hand. The palmar view is stretched and under tension.

"To build a good-looking fist, remember that the second knuckle of the forefinger always sticks out a little"

08: Hands – clenched

When the hand is clenched by forming a fist, the flexor tendons on the wrist show up. The thenar and hypothenar eminence muscles tense and compress all parts of the hand together. The palmaris brevis on the little-finger side of

will be focusing on the visible surface muscles, such as the extensor carpi radialis longus and the brachioradialis. Both of these muscles noticeably twist during pronation and straighten out during supination (fig.05c, fig.05d).

▲ The bicep bulges slightly with supination

▲ Two views of the clenched hand

the hand creates a furrow on the mass of the hypothenar eminence because it tightens and pulls on it. To build a good-looking fist, remember that the second knuckle of the forefinger always sticks out a little, which breaks the silhouette.

Sculpting an archetypal figure

Advanced 3D female

Part 03 | Spine and hips

By Mario Anger

Animator

This part draws attention to the movement of the spine and hips. The relationship between the hips and spine will be outlined, as they are key elements in maintaining the body's balance. The range of motion of each element will be shown through various poses.

01: Spine

The spine, or vertebral column, is made up of individual bones (vertebra). The total range of motion is a result of all bones and muscles working in conjunction with one another. The vertebral column is separated into four main sections as shown in fig.01: the cervical (green), thoracic (red), and lumbar (yellow) vertebrae (collectively called the thoracolumbar spine), and the sacrum (blue), which connects the spine to the pelvic region.

Each of these sections has its own range of movement: rotation, flexion, and extension. Normally the cervical spine is able to extend and flex by 45 degrees, rotate to the left or right by 80 degrees, and flex laterally by 45 degrees. The region of thoracic and lumbar vertebrae – the thoracolumbar spine – can rotate by 30 degrees to the right and left, flex laterally by 30 degrees, flex forward by 90 degrees, and extend backward to 30 degrees.

"The lumbar section shortens by almost 30 percent in an extreme pose, whereas, the thoracic spine is compressed by just one percent"

▲ Vertebral column: cervical, thoracic, and lumbar vertebrae, and the sacrum

▲ This movement stretches the abdominal muscles

▲ The muscles of the back become compressed

▲ Bending forward brings the rib cage closer to the pelvis

▲ This movement activates the back muscles

02: Spine – extension

The thoracolumbar section of the spine is extended by the erector spinae, the lower part of the trapezius, and the quadratus lumborum, which brings the pelvis closer to the lowest ribs. If the spine bends back and the thorax moves away from the pelvis, the rectus abdominis muscle stretches (fig.02a) and the muscles of the back to become compressed (fig.02b).

The lumbar section shortens by almost 30 percent in an extreme pose, whereas, the thoracic spine is compressed by just one percent. The rigidity of the rib cage prevents the thoracic vertebrae from extending as much as the lumbar ones

"The female rib cage is slimmer than the hip bone and is rotated in towards the edges of the pelvis, whereas, the male rib cage is broader and protrudes over the hips when bent"

03: Spine – forward flexion

If the pelvis is fixed in place, the thoracolumbar spine is able to flex by 75–90 degrees; if the pelvis isn't fixed and rotates, the head can almost touch the patella on the knees. The lumbar region bends more compared to the thoracic region and can stretch, on the outside, up to 170 percent of its original length.

Flexing the thoracic and lumbar spine uses the rectus abdominis and oblique muscles; this causes the thorax to move closer to the pelvis (fig.03a). The muscles of the back, like the erector spinae, stretch and flatten, while the muscles on the front shorten and fatten (fig.03b). This causes skin and fat to form big folds around the belly button, right under the bony mass of the rib cage.

▲ The ribs come to the surface during lateral flexion

▲ The rectus abdominis are stretched on one side and compressed on the other

04: Spine – lateral flexion

Lateral flexion is when the spine bends away from the midline of the body to the sides and the thorax moves towards the side of pelvis. This movement is also called abduction and the reversed action is adduction, which brings the spine back to the midline. On the stretched side of the flanks muscles become thinned out and ribs or the costal margin show on the surface of the skin (fig.04a). It's a bony contrast to the opposite side where fleshy and muscular forms dominate under the skin.

The internal and external obliques are involved in lateral flexion, which builds up convex forms on the active side of the body. Also supporting this movement is one side of the rectus abdominis (fig.04b).

The female rib cage is slimmer than the hip bone and is rotated in towards the edges of the pelvis, whereas, the male rib cage is broader and protrudes over the hips when bent.

"Each vertebra adds to the rotation of the previous one and this adds to the total spinal rotation"

05: Spine – rotation

The torso is rotated around the vertical axis of the spine. Starting from the pelvis, each vertebra adds to the rotation of the previous one and this adds to the total spinal rotation. This means that body parts further away from the hips are rotated more than those close to them. Skin is moved and stretched around the torso and forms in horizontal folds on the flanks of the body (fig.05a).

There are a lot of muscles responsible for rotating the spine: the obliques, the psoas major, quadratus lumborum, multifidus, iliocostalis lumborum and thoracis, rotatores, and intertransversarii. It is important to note that of these only the obliques show up prominently on the skin's surface; the others are hidden beneath the surface muscles (fig.05b).

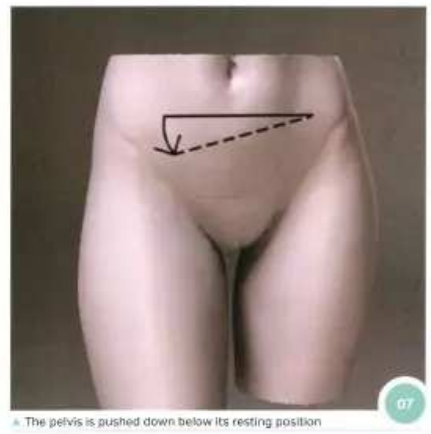
▲ Note the horizontal folds of skin on the back just below the shoulder blades

06: Pelvis – neutral

The pelvis, or hips, allows a wide range of motion for the legs. The ball and socket joints connecting the femur to the pelvis are designed to allow flexion, extension, adduction, abduction, and rotation in wide angles. The pelvis is vital for movement of the torso; it helps the torso when leaning forwards or backwards

When the pelvic muscles contract, the least stabilized body part is moved, for example the trunk is rotated when the legs are fixed or standing, grounded on the feet. Few pelvic motions are caused by the pelvic muscles themselves; they are initiated by muscles of the trunk, hips, and legs that attach to the pelvis or sacrum.

▲ The pelvis in a neutral position



▲ The pelvis is pushed down below its resting position

"The hip lowers its position on the side with the bent leg towards the knee; this causes the greater trochanter of the femur on the straight leg to be pushed out of the body's silhouette"

07: Pelvis – lateral tilt

A lateral pelvic tilt happens if the body weight is shifted to one leg. One leg is bent while the other bears the weight and remains straight. The hip lowers its position on the side with the bent leg towards the knee; this causes the greater trochanter of the femur on the straight leg to be pushed out of the body's silhouette.

Subcutaneous fat tends to cover these landmarks in females, which makes them appear less bony. To balance out the pelvic angle and to remain standing upright, the spine flexes laterally to an inverted angle. This results in the shoulder line being tilted opposite to the hips.

of the thigh like the rectus femoris or sartorius play a big role in this motion.

To keep the body balanced, the rectus abdominis is lengthened and the erector spinae is shortened, curving the spine.

09: Pelvis – posterior tilt

When tilting the pelvis backward, the spine straightens out to its maximum, the lumbar region flattens a little, and the hips extend. The hamstrings and the gluteus maximus pull down on the back of the legs and the rectus abdominis, with the help of the obliques, pulls up on the front of the legs. Folds on the connection between the hamstrings and gluteus muscle deepen as they are pressed together.

▲ The pelvis rotates forward towards the thighs

▲ The obliques are the only major muscle which show on the surface of the skin

08: Pelvis – anterior tilt

The anterior tilt of the pelvis is similar to hip flexion and can result in rotating the thigh or the pelvis. In both situations it decreases the angle between the pelvis and thigh. The anterior muscles

▲ The pelvis is thrust back, stretching the spine

Sculpting an archetypal figure

Advanced 3D female

Part 04 | Legs

By Mario Anger

Animator

Having looked in detail at the shoulders and arms, we will now look at the legs and feet. Many of the same principles apply to the lower limbs as to the upper limbs. As legs are designed for walking, their range of movement is oriented and specialized on a forward-facing axis. We will also look at poses of the knees, upper legs, feet, and toes to show how they are able to move.

The pelvis enables the legs to move in multiple directions. Legs can be flexed forward, extended backwards, abducted to the sides, adducted back to the midline of the body, and rotated inwards or outwards.

▲ Flexion of the upper leg, lifting towards the abdomen

01: Upper leg – flexion

It is possible to raise the femur around 110–130 degrees, bringing the thigh closer to the abdomen (fig.01a). The leg bends on an axis located between the pubis and the lower part of a triangle shaped by the tensor fasciae latae, sartorius, and rectus femoris. It can therefore be imagined slightly lower than the bony landmark of the anterior superior iliac spine.

In this pose the gluteus maximus becomes stretched quite a bit, so it loses convex volume and the wrinkles between the gluteus and hamstrings smooth out (fig.01b). The bony structure of the pelvis, the ischial tuberosity, comes closer to the surface and is ready to bear weight while sitting.

The tensor fasciae latae on the outer side of the leg forms itself into a tear-drop shape and gains some additional volume. Other muscles that

▲ This movement stretches the gluteus maximus

support the flexion are the adductor longus and brevis, iliopsoas, rectus femoris, sartorius, and pectineus.

02: Upper leg – extension

Moving the thigh backwards with a fixed pelvis or straightening the femur joint is called extension (fig.02a). A normal range of movement is about a maximum of 30 degrees. This movement involves the hamstring muscles (semitendinosus, semimembranosus, long head of the biceps femoris, and fibers of the adductor magnus). The gluteus maximus also

noticeably thickens as it pulls on the femur and upper pelvis region (fig.01a).

03: Upper leg – abduction

The rotation of the legs away from the midline with a fixed hip bone is called abduction (fig.03a). A normal range is considered 45–50 degrees. The gluteus medius and minimus pull together with the tensor fasciae latae on the lateral side of the leg. The sartorius also supports this movement.

Indication lines of the fascia lata or iliotibial tract are visible on the skin surface, as are the stretched adductor muscles from the femoral triangle (fig. 03b). The fibers of the adductor longus form a strong cylindrical shape as its insertion points on the superior pubic ramus and the femur move away from each other.

04: Upper leg – adduction

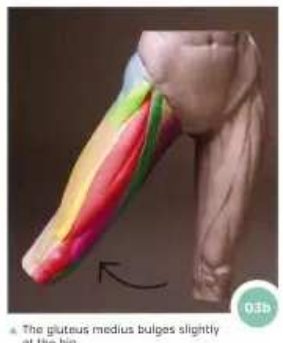
The rotation of the legs towards the midline with a fixed hip bone is called adduction (fig.04a). A normal range is about 20–30 degrees, which allows the thigh to be brought towards and across the midline of the body.

The muscles that allow this rotation are the adductors of the upper leg: the iliopsoas (the psoas major and iliacus combined), pectineus, adductor longus, and gracilis (fig.04b).

▲ Extension of the upper legs, stretching the leg backwards

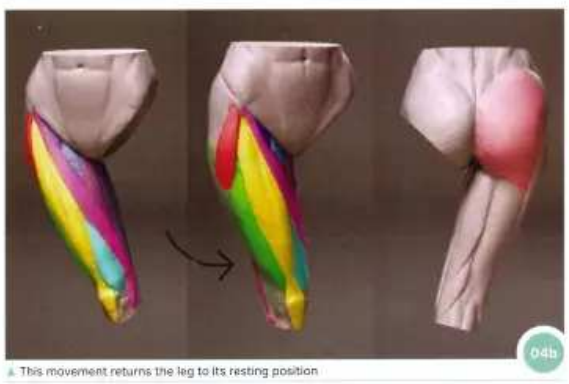
▲ The gluteus maximus pulls on the femur back towards the buttocks

▲ Abduction of the upper leg away from the midline

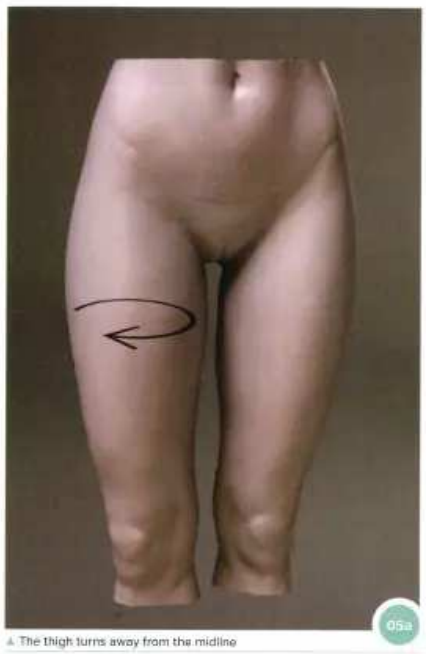


▲ The gluteus medius bulges slightly at the hip

▲ Adduction of the upper legs



▲ This movement returns the leg to its resting position



▲ The thigh turns away from the midline

▲ The sartorius helps to twist the leg outwards

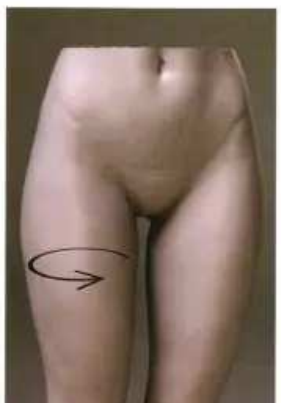
PROTIP

Medial and lateral

There are two types of rotation performed by the body. Internal (medial) or towards the midline and external (lateral) which is away from the midline.

Medial refers to the middle or midline of the body. Medial movement is away from the sides towards the middle.

Lateral is the opposite of medial, it is the side of the body. Lateral movement is away from the middle towards the sides.



responsible for this rotation, such as the gemellus superior, gemellus inferior, and obturator internus, but they are hidden deep within the pelvis and therefore do not show up on the skin. The lower fibers of the gluteus maximus and also the sartorius play a minor role (fig.05b).

06: Upper leg – medial rotation

The opposite rotation is medial or internal, which has a maximum range of about 40 degrees (fig.06a). The bone of the femur rotates inwards around its longitudinal axis. The tensor fasciae latae, the gluteus medius, and parts of the gluteus minimus allow this movement (fig.06b).

> "This floating bone slips into the space between the epicondyles"

07: Knee – extension

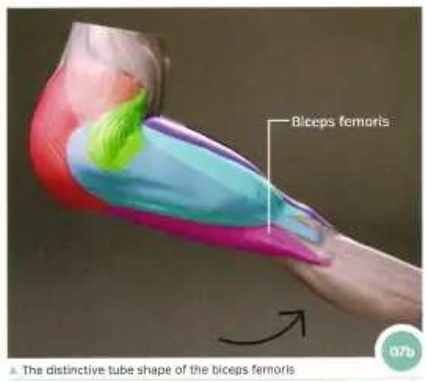
Extending the knee lifts the lower leg up towards the abdomen (fig.07a). The hamstrings muscles (including the biceps femoris) pull on the lower leg to create a tube-like shape on each side of the leg and where there is a negative space between muscles; the knee pit becomes prominent as a hollow depression (fig.07b). There are no big muscular or bony deformations on the lower leg, so the shapes on the surface remain pretty much the same.

08: Knee – flexion (outside of the leg)

The femur of the upper leg sits on the plateau of the tibia, like wheels on a flat plane. If the leg flexes (fig.08a), the epicondyles of the femur roll back on the head of the tibia (fig.08b), thus the upper leg actually rotates and translates backwards.

The insertion points of the rectus femoris on the front of the upper leg move away from each other. The ligament, on which the kneecap is fixed, doesn't stretch when the rectus femoris is forced to enlarge downwards; this floating bone slips into the space between the epicondyles.

▲ Lifting the knee up



▲ The distinctive tube shape of the biceps femoris

05: Upper leg – lateral rotation

Lateral or external rotation can be performed to an angle of 45 degrees (fig.05a). Quite a few muscles are

05a

▲ The thigh turns towards the midline

05b

▲ The knee visibly twists inwards

08a

▲ Flexing the knee

08b

▲ The femur rolls on the head of the tibia

09a

▲ A view of the knee flexing from the inside of the leg

09b

▲ The patella tracks along the femur

09: Knee – flexion (inside of the leg)

On the inside of the leg the sartorius gets shorter and thicker and its insertion points come closer to each other (fig.09a). The vastus medialis is attached to the medial edge of the patella and helps with the correct tracking (following the groove in the femur) of the patella (fig.09b).

10: Knee – medial and lateral rotation

Medial rotation of the knees rotates the patella and lower leg inwards. The opposite movement is lateral rotation, which rotates the patella and lower leg back to, or past, its central resting position (fig.10a). The bony landmarks of the patella point inwards with medial rotation and outwards with lateral.

The muscles on the back of the legs are responsible for this movement (fig.10b). Both of these movements are extensions of the upper leg rotations from steps 05 and 06.

11: Foot – walking cycle

The joints of the foot are indispensable to performing a walking cycle. There are three different phases the foot uses to push the body forward. It flexes upwards, due to dorsal flexion, when

10a

▲ Medial and lateral rotation of the knees

10b

▲ These rotations are mainly performed by the muscles in the back of the leg

11

▲ The three pheses of the walking cycle

12a

▲ Flexing or pointing the toes. You can see the bony landmarks of the phalanges

the heel strikes the ground; it lays flat on the ground when the other foot is passing; lastly, the ball pushes off the ground with the help of plantar flexion.

The Achilles tendon is very strong. It connects the calf muscles to the calcaneus bone of the foot and pulls on it. You can see the Achilles tendon running up the back of the leg – it forms a tube which disappears in the calf muscle.

12b

▲ With extension or lifting the toes up, the tendons are visible

12: Toes – flexion and extension

Toes have a range of movements but it is hard to use them individually; the big toe doesn't have the same mobility as the thumb. Fig.12a shows toe flexion and the muscles on the back of the leg. Fig.12b shows toe extension. The flexor muscles are important for shape altering as they come from the lower leg. The tendons pop out of the surface of the foot when they are activated during extension.

"The Achilles tendon is very strong. It connects the calf muscles to the calcaneus bone of the foot and pulls on it"

Master projects

You have made an archetypal human model; what about some other body types – the muscle-bound hero or the curvaceous leading lady? In this chapter three talented 3D artists guide you through the process of modeling different physiques. Each artist uses a different process in their tutorial; this will help you

Master projects

Male bodybuilder

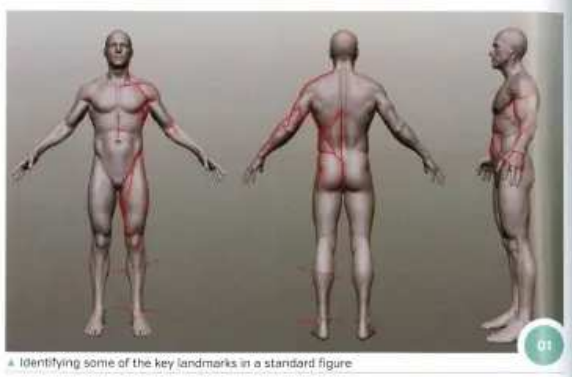
Part 01 | Basic proportions

By Arash Beshkooh

Freelance digital sculptor

This tutorial will familiarize you with the process of sculpting a male bodybuilder figure. Initially, you will begin by learning about the main features of the male human body's form. Using proper software and techniques can be incredibly helpful in speeding up your sculpting process and workflow, but the most important factor in achieving a great sculpt is familiarity with anatomy and the human form.

▲ Creating a base mesh that I will use to build my figure



▲ Identifying some of the key landmarks in a standard figure

First, I will show you how to adapt the main landmarks and forms of an average human figure to create a posed bodybuilder figure. We are going to use a single image as a reference for the pose and muscle volume for the model we are working on.

We will cover the locations and shapes of the bony landmarks that are in direct contact with the muscles. This is about basic proportions and gesture, and defining the important landmarks in the "bodybuilder" physique, which will form the basis for the next two parts covering more specific muscle definition.

01: The bodybuilder physique

Before working on a bodybuilder physique, it would be helpful to compare standard and muscular body types. The first thing that everyone sees in a bodybuilder is the bulky muscle definition, but we also need to know which muscles change, how much they grow, and what kinds of shapes these muscles can be at their largest size. Fat is another factor that affects the form of many bodies but is minimal on the bodybuilder form.

Let's first take a look at the basic shapes and main forms of a standard male body type. In fig.01 I've depicted the most important landmarks with some deep lines. These landmarks do not necessarily show the muscle groups, but they can be affected by the muscle or weight/fat placements on the figure.

> "It's a good idea to work with a very basic mesh for the very first stages of the work"

02: Creating a base mesh

There are various ways to create a base mesh for the human body. For example you can start your model with a box or edge-modeling technique in a 3D package such as 3ds Max or Maya, and then export it into a sculpting software.

▲ The pose we'll be working to recreate. Photo courtesy of www.dollarphotoclub.com

In this case, I start by using a sphere and forming it into a simple torso, and then extrude other basic shapes from it. Once I have all the basic forms established, I retopologize it. It's a good idea to work with a very basic mesh, without lots of edge loops all around the model, for the very first stages of the work.

03: Test pose and gesture

When you want to create a posed character as shown in the reference in fig.03, it's better to do the gesture and pose of your model at the beginning. However, it may not be possible in all programs; I'll therefore show you how to pose from a simple A-pose base mesh.

I automatically mirror the symmetry as much as possible to save time and increase accuracy. You can see that the left and right arms and hands have a similar pose and location, so I quickly pose both the arms as they are in the reference using symmetry.

At this stage, I'm simply recreating the pose by changing the location and rotation of the bones rather than working on the volumes. If part of your model will be symmetrical at the end, however, it's better to work with the symmetry as much as possible before breaking it.

04: Posing the arms

To pose the arms, I start by spinning the arm from the shoulder gradually to the elbow. I rotate the upper arm bone as much as the elbow will go, and curve it down to face to the ground. Manipulating and relaxing the mesh after each transpose is unavoidable.

The forearms also need to be rotated to match the reference. I mask the forearm half-way down as I did on the upper arm. You can relax the mesh if needed when posing the wrists.

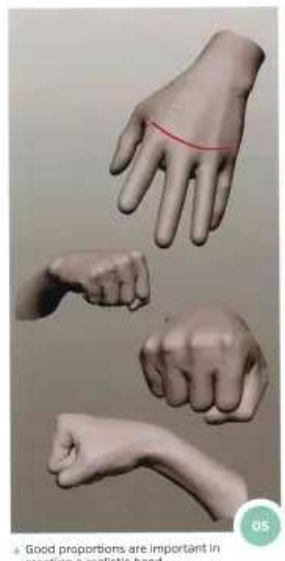
05: Posing the hands

Hands are complex and therefore difficult to pose, so this section often requires more time than other parts of the body.

First, I rotate the wrist so it's facing down a little. Then I pose the four fingers, one by one. When bending the fingers, you should consider where the fingers bend in real life.

Now you can pose the fist. Good knowledge of the bone lengths, proportions, and positions of the joints is crucial in making a realistic hand.

▲ Getting the arms in the right position



▲ Good proportions are important in creating a realistic hand

▲ Making sure both legs are in a level position

▲ Fixing the rotations of the torso

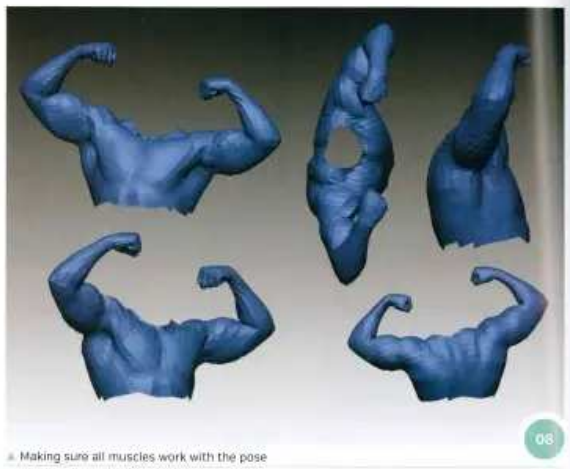
06: Posing the legs

To pose the legs, place the pelvis in the correct position first. You can understand the pose much better if you consider the pelvis as the pivot of the model and the front view as the angle of the camera in your reference picture.

Legs should be transposed from the hip joints. First, rotate the thighs according to the reference, and then rotate the right shin so that the metatarsal bone reaches the same plane level as the other. You can use the grid in your software program to help you out with this.

07: Torso

In the reference you can see that the model's spine moves in all three axes, as I've shown in fig.07. It is crucial to pay attention to the rotation of the torso and consider the underlying rib cage. For this section, leave the lower body as it is and pose the torso. Always take care to keep to the limitations in the rotation of each joint. If needed, we can use our observational knowledge to compensate for the lack



▲ Making sure all muscles work with the pose

in the correct position according to the reference. Make sure your model is on the most basic mesh settings with low subdivisions, and then fix the silhouette and basic proportions. The arms are raised up, so we should also match the volumes of the areas that are directly affected by the arms, such as the chest and back muscles. I usually fix the silhouette using various brushes and tools while still in a low subdivision level.

09: Volumes for the upper arm

I like to split the parts of the body into several simple forms to gain a better understanding of its shapes. Let's do the upper arm first. In this pose, the upper arm has rotated and two sets of muscle mass (the biceps and triceps) appear in the front view. The arms are also flexed, so the biceps have contracted further to make a more voluminous shape.

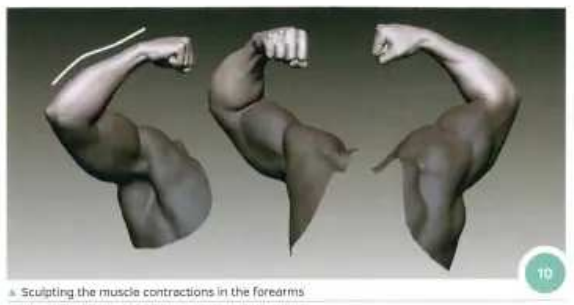
We've already fixed the basic silhouette, so now we need to increase the complexity of the mesh and take the subdivisions up to the next level. Here we can work more on the volume and match the higher points of the silhouette to the reference image.

10: Volumes for the forearms

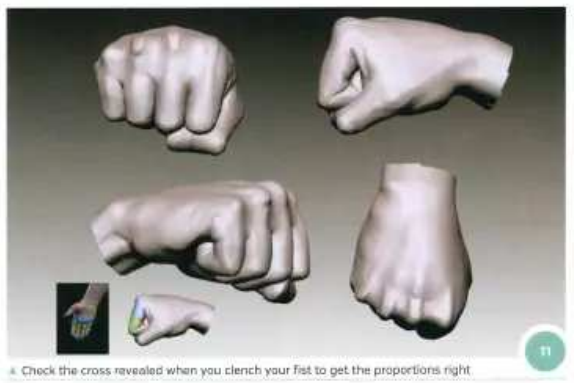
We can use the same process when working on the forearm. Hide or mask the upper arm if you can, then fix the model to match the silhouette. Since our model has contracted muscles, especially on the arms, we should shape them properly and make them feel stiff and tight. Sculpt the top section of the forearm where the forearm extensors are placed and bulge them outward a little to represent the muscle contraction, as seen here in fig.10.

11: Working on the hand

I already made a basic hand before breaking the symmetry, so now let's have a closer look at its form and how the



▲ Sculpting the muscle contractions in the forearms



▲ Check the cross revealed when you clench your fist to get the proportions right

▲ Getting the triangle shape of the torso

of information in our references.

08: Posing the arms using the silhouette

Now we are going to improve the pose and adapt the volumes and gesture to the reference. First of all, place the arms

▲ Refining the volumes and mass of the upper arms

fingers work in a pose. It is important to remember is that a finger's form is closer to the shape of a box than a cylinder.

Sculpt the fingers quickly to get that squarish form; then you can easily add volumes to get the right basic shapes.

When we bend fingers in a fist, the lines between the phalanges form a cross which you can use to get the proportions right (fig.11). Your own hand is the best reference so use it to understand the pose and the volumes that change accordingly.

12: The bodybuilder torso

Bodybuilders have a very low amount of fat; instead, their bones are covered with bunches of bulky muscles. These muscles form an upside-down triangle in the torso, especially when the model raises their

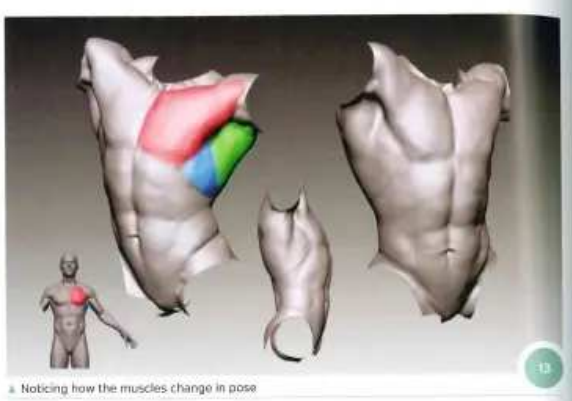
arms like in our pose. This is because the largest back muscle (the latissimus dorsi) deforms and get wider in this pose.

You can sculpt this quickly in a low subdivision mesh. Make sure that your model has the correct silhouette from all angles; match the center of the torso to the reference and see if the bending is the same.

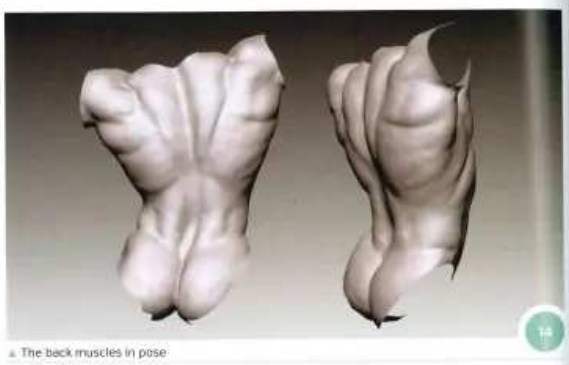
13: Torso: front landmarks

Now we can roughly sculpt the main landmarks of the torso, as illustrated in step 01. There's no need to add any details here but we should define the approximate position and forms of the large muscle masses. Place the chest muscles into the right positions and make a concave shape under the arms as you can see in fig.13.

Pay attention to the pose of the arms when working on the chest muscles because the chest muscles are directly affected by the arms. In this model, the right arm has rotated toward the front a little so the muscles on the right side of the chest have deformed accordingly.



▲ Noticing how the muscles change in pose



▲ The back muscles in pose

▲ Working on the volume of the legs

PROTIP

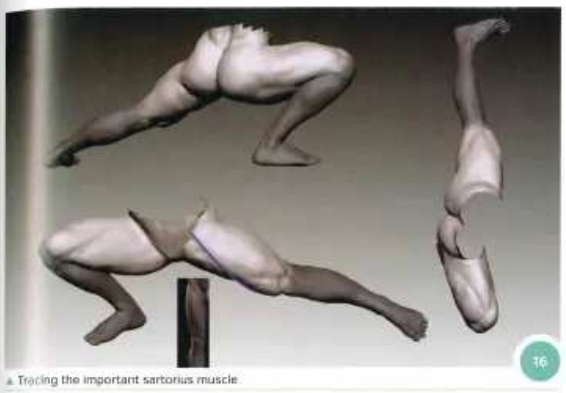
Use light to your advantage

You can also position your light source to match your references in order to have a better perception of the volumes.

14: Torso: back landmarks

As mentioned before, the back gesture in bodybuilders has a triangle-like shape. You should now specify the placement and shape of the main muscle masses on the back. The shape of the muscles may differ based on the biological properties and the training level of the muscles, but the basic form, proportion, and gesture of them are the same.

Fig.14 shows the main shapes of the back and how they are affected by this pose. Some muscles appear when we raise the arms and, because our model



▲ Tracing the important sartorius muscle

▲ Depicting the shin muscles

▲ Making sure the feet reflect the pose and weight distribution

has a very low amount of fat, these differences will be more obvious.

15: Working on the legs

We must observe the balance of the model when we're working on the legs. Check the model from the front and side views to see if the center of gravity is correct. When the pose of the feet is established, we should work on the main gestural form of the legs. In an ideal bodybuilder form, areas that are covered in muscle, such as the thighs, are much larger than areas with less overlying muscle, such as the shins. The parts that are not covered with muscle, such as the wrists and ankles, will be the same size as an average male.

16: The upper leg

Always consider the pose, rotation, expansion and contraction, and gravity when you are working on the volumes. In this model the left thigh is more relaxed, so gravity affects the pull of the skin more and changes the form slightly above the knee. Trace a line from the hip bone to the inner side of the knee – this is actually the sartorius leg muscle. I mention this because it's an important muscle that forms one of the major landmarks of the leg.

17: The lower leg

The shin muscles don't usually get too big, even in bodybuilders. It's important to know the individual muscle group proportions and how large they can become.

Sculpt out the basic shapes of the calves, which should be curved from the front view. Remember that the line of the shin is very slightly crooked, and the shape and position of the muscles give a curved look to the lower leg. The silhouette is almost the same as our reference image, though with sharper points.

18: Posing the feet

At the moment the pose of the feet is quite stiff and straight, which needs to be changed according to the legs' pose and weight distribution. When the pose of the feet is established, move the start

and end of the toes in a low subdivision level and place them in the right position. Checking the feet from the top view helps in getting the right proportions.

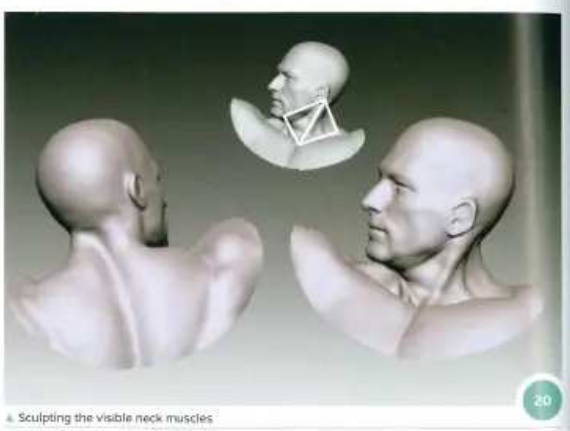
19: Working on the feet

Once we're sure the proportions of the feet are correct, we can work on their shape and angle, and the length and position of the toes. To get a better understanding of foot anatomy, study the forms and landmarks and exaggerate them in your mind; establish exaggerated and simple forms, and then refine the model based on real anatomy. Check the toes and see if they are extruding from the right place; they should look longer from the top view.

20: The neck

Rotate the head and upper half of the neck gradually so that its position matches the reference image. Now block out the sternocleidomastoid, the muscle that starts from behind the ear and ends at the clavicle. When we rotate our neck, one side of the sternocleidomastoid will disappear from view and the other will become more visible. This leaves two triangle shapes in the side of the neck if we look from the front view. Remember to turn the neck based on the spine as its axis.

▲ Working on the silhouette and bony landmarks



▲ Sculpting the visible neck muscles

21: The bony landmarks on the arm

We'll now work on the key skeletal and bony landmarks of the model. This is the last step before sculpting the muscle definition. These bony protrusions are essential because they help us to divide the body, understand proportions, and see where the visible muscles meet the bones.

as this model has flexed his arms, the middle protrusion on the elbow pushes out and they form a triangle together.

22: The bony landmarks on the leg

One of the most important bony landmarks in the body is the visible part of the hip bone, called the iliac crest. It creates a dividing line between

Another thing to note is the knee protrusions. One is the kneecap, which has three points and a general triangle shape; two others belong to the lower leg bones.

Finally, on the ankles, the inner protrusion is placed higher up and further out than the outer one. Sculpt them and drag a line from them to form the tendon and muscles attached to them.

23: The bony landmarks on the torso

In the torso we define the chest muscles by the rib cage and clavicles, though they are not visible in this body type (especially in this pose). The same is true for the spine of scapula, the bony landmark where two big muscles meet.

The cervical curve of the spine also makes a landmark in the back of the neck – the 7th cervical vertebra is the largest one and is usually visible.

▲ The bony landmarks visible on the legs

▲ Identifying the bony landmarks on the arm

The arm has five important bony protrusions as depicted in fig.21. We can see three of them in the elbow: one is located in the middle and is part of the ulna and the two beside it belong to the humerus. When the arm is straight, these protrusions are in a straight line, but

the lower and upper body. The next landmark is located beside the hip bone, and is part of the thigh bone. This isn't very visible in this model because of the pose, but it's important to know its size and position because it defines the basic form of the pelvis area.

▲ The bony landmarks of the torso

Master projects

Male bodybuilder

Part 02 | Refining the muscles

By Arash Beshkooh

Freelance digital sculptor

In this part, you'll become familiar with almost all the visible and important muscles in the body and see how they change according to pose and body type – in this case, a male bodybuilder.

Learning about muscles is crucial for sculpting a figure, and the more knowledge you have about the form and location of the muscles and bones, and the connection between them, the more accurate your results will be. Keep in mind that it's always better to make learning and studying a priority. You need to know about the importance of the muscles and bones because these are the first things you'll tackle after setting the basic proportions; you'll sculpt the most important muscles and bones, and they will guide you toward the less important ones and other details.

In the following steps you will become familiar with the muscles in each part of the body and come to recognize their approximate shape and location in this bodybuilder pose. I've divided the muscles into several parts based on their functionality and relationship with each other, in order to make it easier to understand, but you can separate them in your own way for study if you prefer.

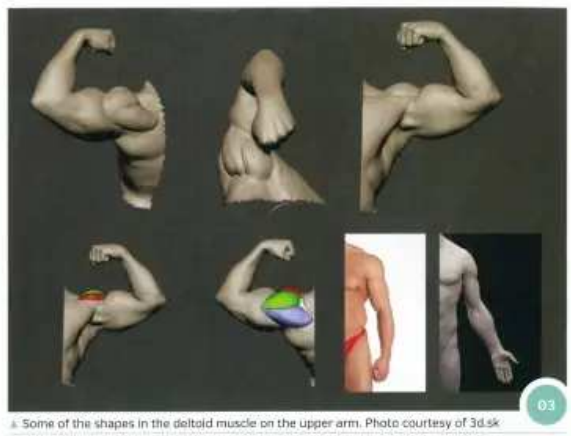
▲ Bad topology, like you see in the red circled areas, will be a big problem later in the sculpting process

▲ One basic muscle-sculpting process

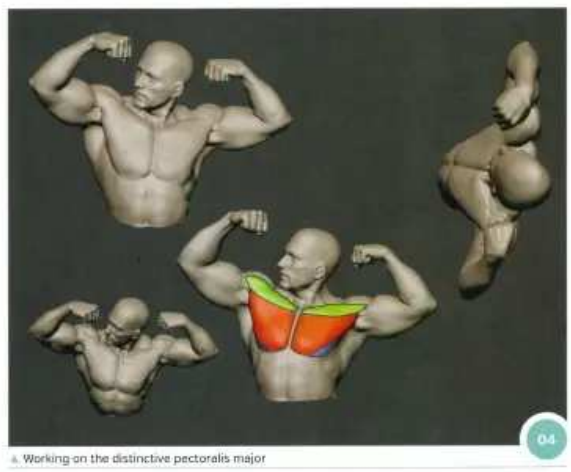
PROTIP

Muscles connect to bones

Remember that all the muscles are attached to the bones, and bones have the same structure and proportions in both average and bodybuilder figures, so it's important to know the basic skeletal forms and places where tendons are attached to the bones.



▲ Some of the shapes in the deltoid muscle on the upper arm. Photo courtesy of 3d.sk



▲ Working on the distinctive pectoralis major

01: Retopologizing the model

Before getting your hands dirty with sculpting the muscles, you should make sure that the topology of your model is good. The best topology for sculpting is something with quad faces within a fluent mesh. As we have rotated some parts too much, some polygons have become extremely stretched, which will be annoying to work with and reduce our control of the mesh. To avoid that, I retopologize the model when I've established the pose and all the basic forms.

02: Muscle sculpting method

This is a great place to show you how I sculpt the muscles. I usually start by using a brush to stroke along the length of the muscles to specify their basic shape and position and then refine the volumes by stroking along their width. Finally, I smooth them out to clean up the mesh. You should repeat this process until you get your desired result. This is not a rule, though; you should experiment with different methods to determine what brush and method is the best for you with regard to the software you use or the models that you sculpt.

03: Defining the deltoid

Let's start our sculpting with the arm muscles. The arm starts with a muscle called the deltoid, which is stretched from the collar bone in front of the torso and the spine of the scapula in the back, and ends at the humerus. If you look at the bodybuilder physique, you'll notice that this muscle doesn't have the form that you see in an average figure – its shape has changed to something a little rounder and more pronounced.

Deltoid muscles are divided into three parts: the anterior, medial, and posterior sections. The anterior part is attached to the clavicle and is more defined compared to the two others. As the arms are rotated, this muscle is moved to face the back.

04: Defining the chest muscles

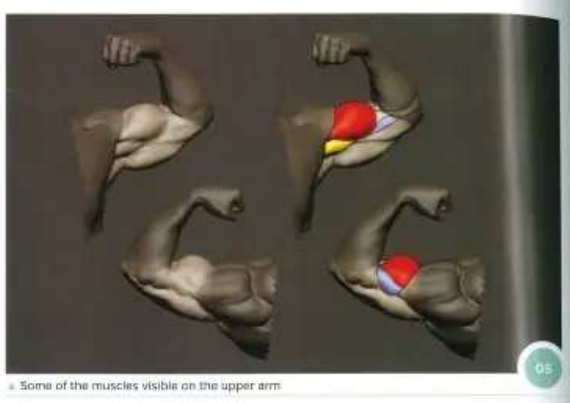
As the chest muscles are located side by side with the deltoids, it's important to sculpt the chest and deltoids together. The chest muscle, or pectoralis major, has three divisions: the upper part is attached to the clavicle; the middle and largest part is attached to the sternum; a small part in the lowest area is located over the abdomen. They all have a single common insertion point at the humerus. As the

arms of our model are raised and rotated, these muscles are deformed as well.

05: Defining the biceps

The next muscle is the biceps. This muscle is made of two parts, but they appear as one. The origin of the biceps is actually at the coracoid process of scapula.

In this pose, this muscle is very contracted and the shape has deformed to something more spherical. Leave some space at its end because the muscle is shorter as it's contracted and the rest of the space along the bone is now occupied by the taut tendon. There is also another muscle beneath the biceps called the brachialis. In an average body type, the brachialis is usually invisible because of its size, position, and the amount of fat, but it's crucial to sculpt them into the bodybuilder form as well as the other muscles. You can also see other muscles near the biceps in fig.05.



▲ Some of the muscles visible on the upper arm

06: Defining the triceps

Now let's define the largest muscle in the upper arm, located right behind the biceps. The inner triceps are shorter and are called the lateral and medial heads. The tendon plate of the triceps' three heads makes up a large part of the arm's shape. It's important to define the angle and proportion of the tendon and muscle correctly to give it a realistic look.

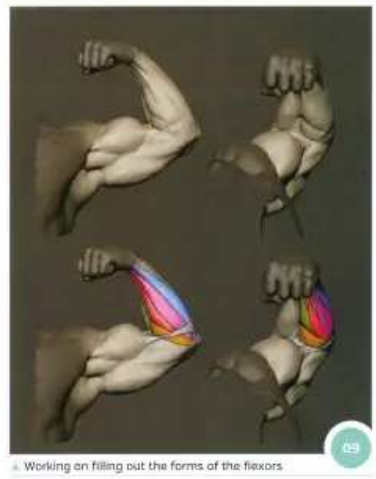
▲ Defining the shapes of the triceps muscle in the upper arm

07: Defining the forearm muscles

The forearm includes several muscles overlapping one another and it's a bit confusing to memorize all of them at first. The goal is to get a realistic result and enough accuracy to look believable. If we divide them into three divisions, it becomes easier to study and sculpt them.

The first section includes two muscles: the brachioradialis and extensor carpi

▲ Outlining the forearm extensors



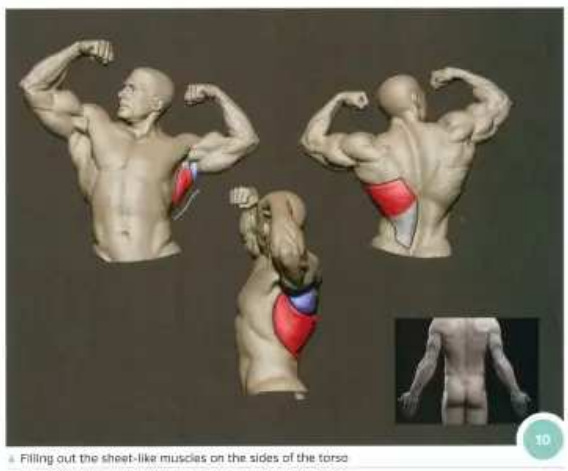
▲ Working on filling out the forms of the flexors

the tendons. It's very important to get the muscles' shape right, especially when contracted. This muscle group usually appears as one muscle on most people, but it shows up in two on more developed body types with a very low amount of fat. You should define it as fig.07 shows, though remember that since this arm is flexed, the muscle here is bent accordingly.

08: Sculpting the forearm extensors

Next, trace a line from the protrusion of the humerus (the lateral epicondyle) to the place right above the head of ulna. The space between this line and the muscles that we defined in the previous step is the place where the forearm extensors are.

The largest muscle in this area is extensor digitorum. If you define the largest muscle, you can simply figure out where the other muscles are in the immediate vicinity and define them as well; this is



▲ Filling out the sheet-like muscles on the sides of the torso

belongs to the flexors. It's better to start with the muscle that's located approximately in the middle of the

10: Sculpting the latissimus dorsi

The most vast muscle in the body is the

radialis longus. Note that these muscles belong to two different muscle groups, but since their location and forms are very similar, I'm introducing them as one here.

When we sculpt the muscles, we should consider the position and length of

▲ Contours created by the muscles in the forearms

usually the way I work, by sculpting from the largest muscles to the smallest.

09: Sculpting the forearm flexors

The space that's left between the previous muscle groups of the forearm forearm, called the palmaris longus. You should add two muscles beside it as shown in fig.09. The final flexor muscle, the flexor carpi ulnaris, stands right beside the extensor carpi ulnaris and the head of ulna, which we have sculpted previously as a bony landmark.

latissimus dorsi, though it's very thin for its size. Sculpt this muscle from under the arms to the highest point of the hip bone. The sides of this muscle have deformed in this pose because of the underlying muscle called the teres major. There is a diamond-like landmark in the lower

part known as the lumbar aponeurosis, which is more defined in bodybuilders but almost invisible in less muscular figures.

11: Defining the neck muscles

The trapezius is another big and important muscle that is stretched from the lower back of the skull to the lumbar aponeurosis. The sides of it are attached to the spine of the scapula, which is why it seems divided in bodybuilders. These two parts are not as defined in a regular figure, but are completely visible in a bodybuilder, especially in this pose. It's therefore important to take notice of that and make the upper part more bulky in this pose. In fig.11 you can also see the other visible muscles of the neck from the front view.

12: Sculpting muscles around the scapula

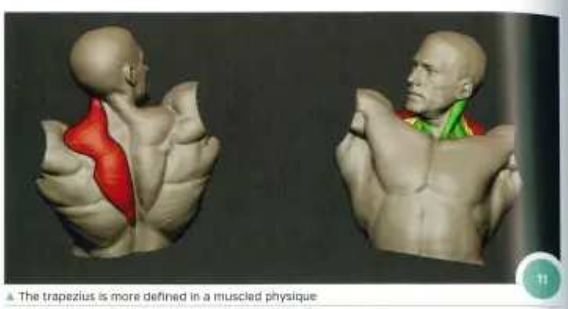
Since we have sculpted all the muscles I've mentioned around back of the torso, there will be a triangular shape left over the scapula. Some of these muscles are beneath the others and are not visible. To know the shape and position of them, you should study the bone beneath them first and see how they work together.

There are three muscles in this area that are visible, but the biggest one you need to pay attention to is the teres major (as depicted in fig.12). This muscle also becomes more pronounced as the arms are raised.

There is also a muscle aside from those three muscles that stretches from the vertebra to the scapula. It is almost invisible, but if the arms are raised a little part of it become visible, particularly in bodybuilders.

13: Serratus anterior

These muscles are stretched again from the scapula, but this time to the rib cage. Usually four of them can be seen because the upper ones are covered with other muscles. The ends of them should form a curved line as the line of the rib cage is not straight. You should avoid exaggerating the form and size of these muscles.



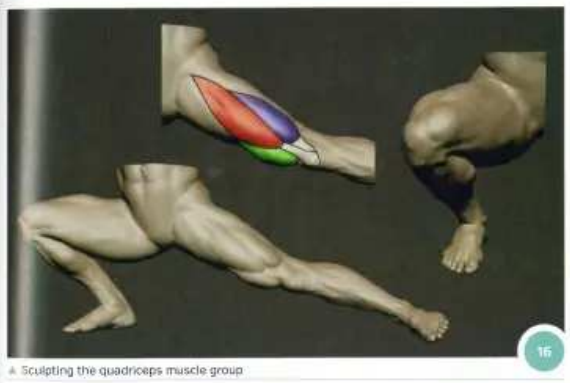
▲ The trapezius is more defined in a muscled physique

▲ Contours in the silhouette of the torso

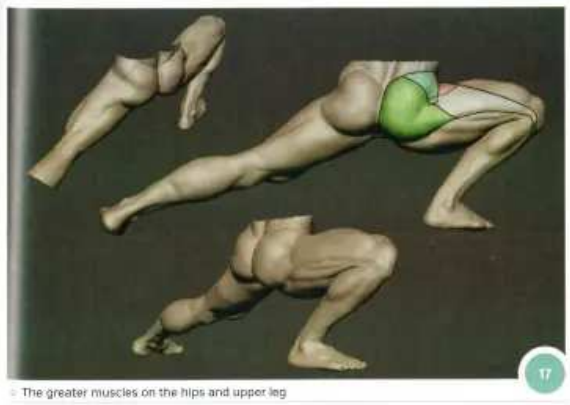
▲ Outlining the muscles surrounding the rib cage

▲ Defining the external oblique muscles

▲ Placement and distribution of the abs



▲ Sculpting the quadriceps muscle group



▲ The greater muscles on the hips and upper leg

14: External oblique

The external oblique muscles are in a direct relationship with the previous muscles; they are stretched from the abs and interdigitated with the serratus anterior muscles. They are always flatter compared to the serratus muscles, and the lower part of the external oblique has a completely different shape which is much bigger, longer, and more bulbous. This bulky part plays an important role in making the overall shape and silhouette of the body.

15: Abs definition

The shape and lineup of the rectus abdominis muscle, or abs, can be different from one person to another. Some people have crooked abs and some straight; some have abs that slant in the center, others have straight lines. Basically, then, you are free to sculpt this muscle specifically using your reference.

There are some basic rules you should consider, however. For example, there should be three sections of muscle on both sides above the navel, and a larger section below. Note that the position of the navel can be slightly different in different people.

16: Sculpting the quadriceps

There are four main muscle groups in the upper leg and from the front view you see one of the most important: the quadriceps. This muscle group includes three visible muscles (and a fourth hidden one, hence the "quad"): the rectus femoris in the middle, the vastus lateralis at the outer side, and the vastus medialis in the inner side. As you can see in fig.16, the model has some fat which fades out some of the muscle forms, but I'm going to go a bit further with the muscle definition so that you can see the muscles clearly.

17: Sculpting the gluteal muscles

This muscle group is focused around the pelvis. The muscles in this part are attached together at the side and stretch down to the below the knee with the iliotibial band. You can see that a pocket

forms on the sides of the hips due to the position of these muscles, but the extent of this will depend on the pose of the legs.

18: The adductors

This muscle group is located on the inner part of the upper leg, and its job is adduction (moving inwards towards the center line of the body) and rotation of the legs. These muscles are barely seen, even in bodybuilders, but part of this area where two muscles are attached to the hip bone by tendons can be seen in almost all body types in many poses. This part is therefore crucial to sculpt.

You can see the tendon in fig.18. There's a long muscle beside this muscle group which creates a splinting landmark line on the leg. This long, thin muscle stretches from the bony landmarks of the anterior superior iliac spine to below the knee.

19: Defining the tight flexors

The next and last muscle group in the upper leg is the thigh flexors located on the back of the thigh. Start defining them first by splitting that area into two parts: the biceps femoris and semitendinosus.

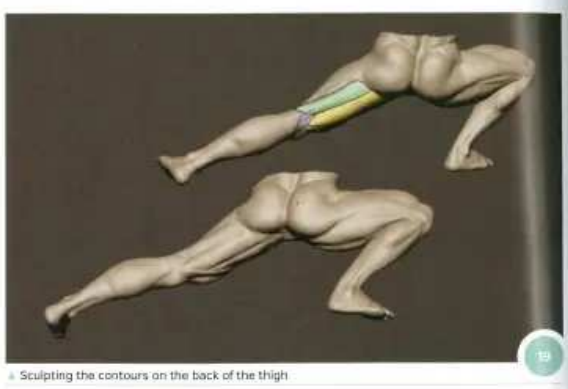
Remember to keep the overall forms correct and sculpt these muscles in a way that means you have the main shape of the legs while having the right forms of the muscles.

20: Lower leg muscles

This part of the body is harder to sculpt because all the muscles need to be placed in a very limited space while still maintaining the correct overall shape of the lower leg.

Like in the previous step, define two muscles in the back of the lower leg and then add the extra muscles beside them. From the front, you can see that the tibia is not covered with muscles. If you define

▲ The visible muscles on the inner thigh



▲ Sculpting the contours on the back of the thigh

▲ The muscular arm in a contracted pose and the reference image we're trying to match. Photo courtesy of www.dollarphotoclub.com

▲ Study your reference to get the angles and volumes right

▲ Checking the muscles in the leg

changed in the arms. Use the reference to match the silhouette from the main view as closely as possible, then refine the model from other angles as well. Just remember to maintain the shape of each muscle during this process.

22: Refining the torso and back

The same process applies when modeling the torso: look at the angles of the parts of the torso and apply the same proportions and angles to your own model. There are two lines that help with getting the pose right: the middle line of the abs and torso, and a horizontal line across the chest muscles, right above the abs.

23: Refining the legs

▲ The model so far

with symmetry switched on, try to match one leg's muscles to the other one.

smooth everything out; leave some sharp edges between the muscles (unless you're working in a more cartoon-like style).

this section correctly, it will be easier to position the other muscles around it.

21: Refining the arm muscles

Now we are going to adapt these defined muscles to suit our model's pose. You'll notice that some volumes have been

Refining the complex shapes of the muscles in the lower leg

Right now some of the interconnecting muscles in the leg might be crooked, so you can refine by fixing their size and location. As I've said before, if you set the main muscles properly, it becomes easier to take care of other muscles around them. Also, since you are not working

24: Adding skin and imperfections

When it comes to realistic organic modeling, you should be a bit messy, because organic models always have some variations and imperfections in their muscles, skin, bones, and fat. Don't

Try to use your memory and imagination to make some variations in volumes and details of the skin and muscles too. We'll talk more about this important part of the organic sculpting processes in the next part.

Master projects

Male bodybuilder

Part 03 | Refining volumes and adding detail

By Arash Beshkooh

Freelance digital sculptor

In this last part I will talk about refining volumes a little more, adding imperfections, and detailing each part of body. As we proceed, we will add details including skin textures, wrinkles, muscle fibers, and veins for each part of the body separately.

I will also describe how to refine those basic muscles and forms to create something more natural, which is an important part of the sculpting process for organic models. Then we will look at lighting and final touches, which are described briefly as the final process.

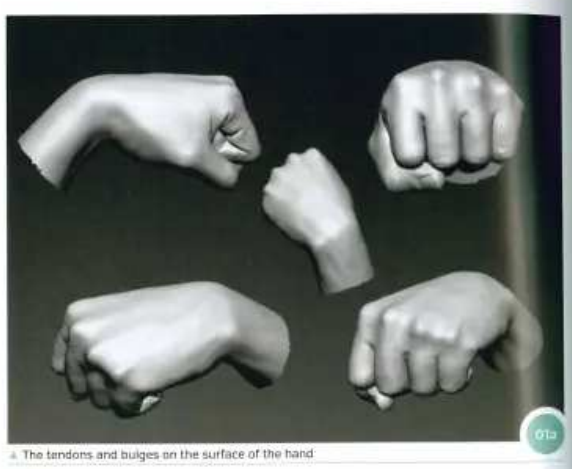
The detail of the model is important because besides making the model more realistic, we also need to indicate the material of the model with the texture of the model's surface.

The most important part of character creation, however, is getting the basic forms and silhouette right; if you feel like something is wrong with the overall shape of the model anywhere in the sculpting process, you can refine it without concern for losing details at those lower subdivision levels.

"Muscles, wrinkles, tendons, and bony protrusions can change a lot in different poses and situations"

01: Hand details

I want to start by working on the details of the hand. When you are working on the hand, you should take the pose into consideration because the muscles, wrinkles, tendons, and



The tendons and bulges on the surface of the hand

The wrinkles on the clenched palms of the hand

bony protrusions can change a lot in different poses and situations.

For example, in this pose we have a clenched fist, so the finger joints bunch up. If you make a fist with your own hand, you'll also notice that the tendons become less visible (fig.01a), whereas if you spread your fingers wide, they will become bumpier.

"Creating proper variation for the wrinkles is also essential. To do this you should be patient and try out various wrinkles on your model; at the same time you must also have some idea of the final result"

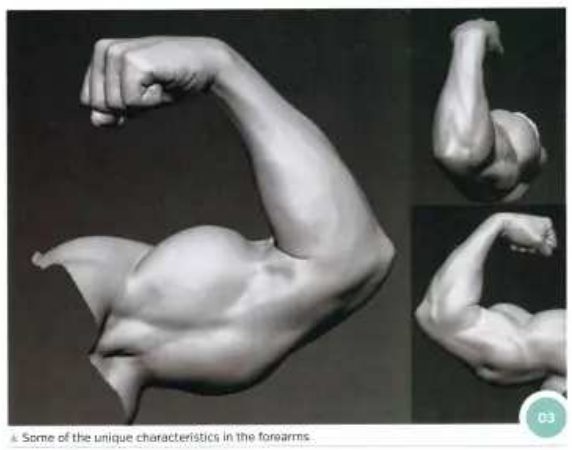
Next, we will sculpt the wrinkles and the skin details of the hand. It is important to make sure that you sculpt the form and depth of the wrinkles according to the material and pose of the subject.

Creating proper variation for the wrinkles is also essential. To do this you should be patient and try out various wrinkles on your model; at the same time you must also have some idea of the final result you are aiming for (fig.01b).

02: Refining the arm volumes

We have already set the position and the shape of the muscles but they still need to be adjusted to look more natural. For example, you can see the triceps developing in fig.02.

Revising the volumes of the arm muscles



Some of the unique characteristics in the forearms

PRO TIP

Use subdivision levels

One useful tip in organic modeling is to have several subdivision levels. This way you can go back to a lower subdivision and adjust the basic forms if necessary without losing your details in the higher levels. This is a useful advantage of digital sculpting which we might as well utilize.

Hide the forearm and check the biceps from the top view and see if it has the correct shape. Adjust the silhouette and thickness of the arm in different parts to make sure it matches your reference.

03: Detailing the arm

There are lots of muscles and muscle fibers on top of the forearm that make visible lines on the surface. You can emphasize some of these or smooth some out to create a good variety of textures. You should use references in order to gain a better perception of what this should look like.

Note that it is not necessary to copy every little detail from the reference. You should use the reference just to gain an idea of what kind of forms you should sculpt, and to make your model's individual characteristics distinguishable.

04: Adding wrinkles to the arm

After finalizing the muscle details on the arm, it's time to add the skin and wrinkles. Bodybuilders have a very low amount of subcutaneous fat, so the wrinkles form accordingly. As skin is very thin without fat, it rumples with very small movements, stretches, or rotations. The visibility of the muscle fiber and tendons also depends on the amount of the fat beneath the skin. You can add those micro-wrinkles by sculpting lightly with an appropriate brush.

05: Lighting the arm

Now that the arm is almost done, it's time to check it from various angles under different lighting. This way you can get a better understanding of the volumes of your model. Change the lighting direction in order to see if everything looks good in that lighting as well. This can also be helpful in getting the proportions right. During the process of sculpting, it's also a good idea to do some renders with shadows to help you get an idea of the final result.

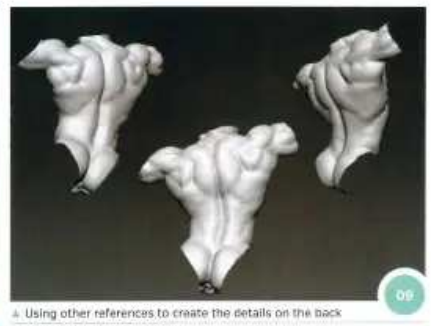
06: Refining the torso front

The torso and back need some changes as well as the arms. In this stage you should refine the shape of the muscles and give them a better volume. Try to get rid of the sharp edges around the muscles and give them a more organic look. As you can see in fig.06, I've made the chest muscles more voluminous and also made some changes to the obliques.

Bodybuilders have more wrinkles due to there being less body fat

Check the details and proportions under different lighting conditions

Depicting the stretched muscles in the torso



Using other references to create the details on the back

PRO TIP

Understand the volumes

You can use references to get a good shape and silhouette, but sometimes the volumes that you see in the reference image are not so clear due to the texture, improper lighting, and so on. It's therefore important to have a good concept of the volumes and depth of the cuts between the muscles.

Refining the shoulder muscles on the model

07: Detailing the chest

In the torso we should now add the imperfections and details, such as some breaks in the lines between the muscles and some skin details on the chest.

When adding the muscle fibers, you should be aware of where they are visible and where they are not. For example the chest muscles are usually soft and polished, with or without a few visible muscle fibers (though this depends on the contraction of the muscle).

In the area where the arms are attached to the torso, we can add skin details by

appear flat, stiff, and longer than they would in a relaxed position. I've continued the shape of the obliques over the abs here too. The oblique muscles end when they reach the abs, but these muscles are attached to the thin layer of broad tendons (the aponeuroses) which cover the abs and affect the shape of the obliques in different poses.

While sculpting the stretched muscles, give some variation to the length and depth of each protrusion and make the stretching in this area perceptible, but avoid exaggerating them.

10: The shoulder muscles

We've already defined the muscles in this area but they need to be refined so they are more in-keeping with the pose. To do that, I've made some changes to the volumes and forms. As you can see in

and so on. This is how I capture the detail on the back of the model. Some aspects matter less when using references. For example there are variations in the backs of bodybuilders, so you won't always be able to find a single perfect reference. What really matters is that the type of body, in terms of the fat, muscle size, and so on, is consistent in our model.

▲ Refining the muscles on the torso

▲ Adding subtle muscle definition to the torso

sculpting some very tiny wrinkles. They should not be deep, just very shallow cuts which give a nice look in the highlights.

08: Detailing the abs and obliques

The abs are stretched in this pose, especially on the right side, so they

09: Refining the back muscles

A good way to use references to improve your forms is to use several references from different poses (according to our model and its pose) and use each one for a separate part of your model's body. For example one image for the upper body, one for the lower body, one for the arms,

in Fig.10, I've blended the volumes of the deltoid and infraspinatus muscles and also reduced the size of the teres minor muscle a little. Just remember that when creating imperfections in these areas, the right and left sides should not be too different if the poses of both arms are almost the same.

11: Adding wrinkles to the back

Now we need to adjust and detail the rest of the back muscles. On the left side of the waist we should add some wrinkles that have been formed due to spine rotation. As hinted at in step 04, the size of the wrinkles depends on the amount of fat, so the wrinkles are thinly spaced in bodybuilders. When adding the wrinkles, remember not to exaggerate the quantity or the depth too much.

Try to add some details to the skin to make it feel thin with a very low amount of fat under it. There is no need to work on the minor details too much, as we are going to add the veins and other details in this area later.

▲ Adding appropriate skin wrinkles to the back

PROTIP

Try changing the material

Changing the material can also be helpful to check detail. For example increasing the glossiness gives you the ability to see the small details and wrinkles that are almost invisible in a matte material.

▲ Checking the silhouette and details under different lighting conditions

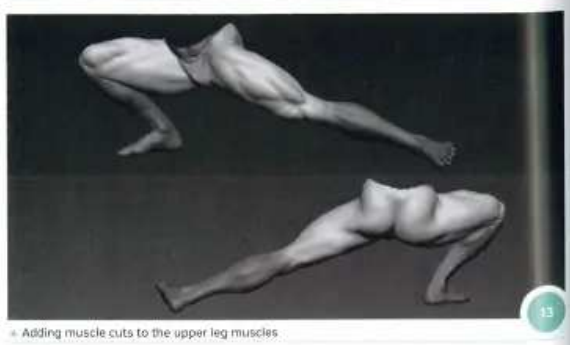
12: Lighting the torso

As we did with the arms, we should check the torso under various lighting conditions. Set some lights at the sides and the top to see if everything about the volumes and skin wrinkles looks correct. By adjusting the diffuse curve you can also see the silhouette of the model better.

13: Working on the upper legs

Now we can start to refine and add details to the upper legs. Add some breaks in the muscles to make them more natural. Again, for an organic model everything has to have some imperfections, including the divisions in between the muscles, surface, and muscle fibers.

Consider that each muscle has its own features and takes on a special form when its increases in size on a bodybuilder. When you add cuts into the muscles you should always consider the



▲ Adding muscle cuts to the upper leg muscles

▲ Cuts in the model must follow the volumes of the muscles

direction of the muscle fibers. You have to take these details into consideration in order to make believable anatomy.

14: Working on the lower legs

Lots of muscles are placed in a small space and have a higher complexity compared to other parts of the body. When refining these muscles you should imagine each muscle individually, placed among the other muscles – not just as cuts in the body. Placing dividing lines into the model can help us to define the muscles at first, but when refining you must think about their volumes too as they are several single muscles forming a larger shape together.

▲ Be selective when placing details on the model

Another thing that we should consider for the lower leg is the pressure applied to the muscles. In this model we have the right lower leg under pressure which causes its deformation.

15: Detailing the legs

Now it's time to work on details like the skin wrinkles and muscle fibers on the angles where the legs are bent, as we did for the arms and torso. First, smooth out some parts of the legs to reduce the definition of the muscles and make it feel as if the skin is covering them. Try to match the legs with other parts of the body and make a harmonized model. Don't sculpt details on all the muscles because it would be too exaggerated and far from realistic. Usually the muscle groups that have the most visible muscle fibers are the gluteals and quadriceps in the upper legs, so you should focus on these.

▲ Make sure the broader forms and volumes are correct before adding detail

16: Feet details

Before going for the details of the feet, make sure the overall forms are right. In order to do this, check the feet from top and bottom and ensure they have the correct shape. When you work on a crooked leg as in the left side of our model, you should rotate your view to make the left leg appear vertical on the screen so you can recognize mistakes and fix them in a more accurate way. From there, you can start refining the details of the bones and tendons which, like the hands, are the main parts of the feet.

▲ Setting different lighting conditions to check details on the model

▲ Adding a little noise to the surface of the model to imitate skin texture

17: Check the legs and feet

It's good to check each part of the body individually, so I want to apply the same checking process to the legs and feet that I did for the arms and torso. Once again, set the light direction to various angles to check if there's something wrong; then clean up your mesh and refine the volumes, remembering to maintain the imperfections of your model.

18: Adding noise

Most organic surfaces have some noise, but the strength of the noise varies depending on the subject. For example children have very smooth skin, whereas people with larger quantities of fat under their skin have stronger skin noise due to the texture of fat. For bodybuilders, we should add some noise to make the skin rougher. The strength of this roughness varies in different body parts and makes the model visually better by filling the empty and polished surfaces.

Sometimes I apply the noise even before finishing the model, especially for the face. You can use alphas if your sculpting program is able to do that.

19: Using alphas

Usually you wouldn't apply the same

patches differs between individuals, but they are generally fairly common on the chest area. We can apply these details using very simple alphas, positive for these protrusions and negative for the very small skin pores.

You can add these details alongside the noise to make the model more realistic. Also, don't be afraid of adding details by hand after using alphas – it can make the model appear more natural.

▲ Getting the skin texture right with pores and protrusions

20: Adding the veins

When everything is done and all the forms and details are established, it's time to sculpt the veins (fig.20a). The veins have their own anatomy, though you can easily research the approximate locations, size,

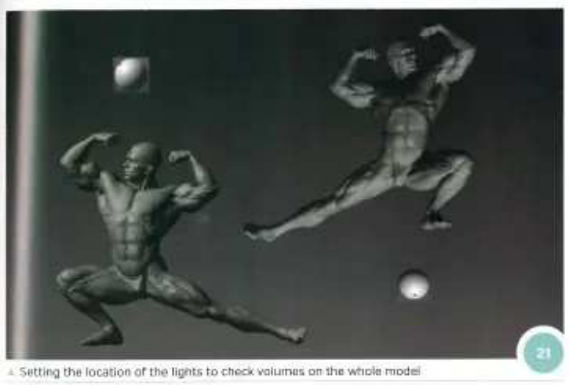
▲ The vein networks on the upper arm

and paths of them. Every single person has a unique pattern for their veins' path, like a fingerprint, but we should consider the basic anatomy for the veins that are common in different people, in order to achieve a believable character.

First let's start with one of the largest visible veins, which is roughly located between the biceps and triceps in the arms; we'll then sculpt the other smaller ones. We can see a greater number of veins beneath a bodybuilder's thin skin compared to a more average body type.

"Various lighting angles can help us to see the volumes better"

Note that veins are denser on the arms and legs. Pay close attention to the veins on the arms because they really catch the eye in this pose (fig.20b). Getting these right can make it seem as if the muscles are stiffer and contracted with the veins. This can really help us to take the model's visual strength to the next level.



▲ Setting the location of the lights to check volumes on the whole model

21: Lighting

Now that the model is finished, it's good to check the whole model under various lighting conditions. In fig.21 I've indicated the location of the lights for each render. As I've mentioned before, various lighting angles can help us to see the volumes better, but in addition you can also get an idea of the final result and see any the flaws in the sculpt before a final render. You can also test your model with shadows, ambient occlusion, and so on to see if everything works with the volumes, but usually just changing the light's location in your sculpting software will be enough.

22: Final touch

The last thing we will do is add the final

skin pores that you used for the face to the body, because the face's skin pores are larger than the body's. However, sometimes bodybuilders' skin has little protrusions where the hairs grow, as we usually see on the neck where the beard is. The location of these rough

20a

▲ The map of veins over the model

22

▲ Final render

improve the model. All the details we already added can inspire us to add new details and finalize the model. At this stage you can also add some additional details to your model that do not exist in the reference, such as more wrinkles or a different level of skin roughness.

Master projects

Curvy female

Part 01 | Basic form

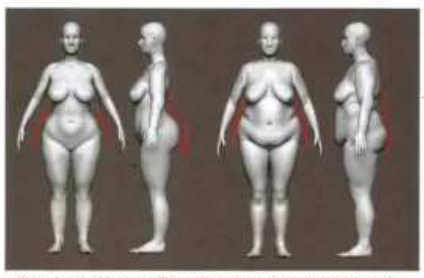
By José Péricles

Freelance digital sculptor

Female figurative sculpting is a very subtle and gentle art. The archetypal female form is very delicate and the more curvy figure is no different. I might even say it's harder, because more observations and references are needed, which is something we don't always see as much of with the standard body type.

Women naturally have more body fat than men, which makes the surface smoother. With fewer visible landmarks, the proportions seem a little different: the legs are shorter and the torso is longer (also thinner in profile). When we think about sculpting women, we need to remember that the most distinct difference between the two genders is that everything is generally longer and thinner in the female form, such as the hands, feet, and fingers.

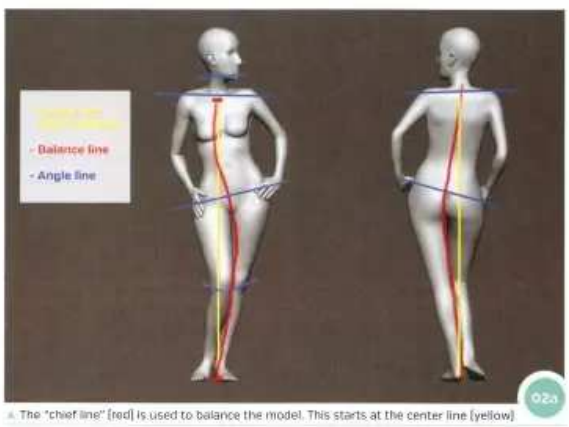
Bony landmarks are usually very important, but since there is a lot of soft tissue on top, they can be very hard to see. We therefore need to focus on searching for the best way to check them because they will be the key to making sure the proportions are on the right track.



▲ Note that the hips are still prominent, even on an overweight body

01

▲ Concentrate on getting the pose you want early on



02a

▲ The "chief line" (red) is used to balance the model. This starts at the center line (yellow)

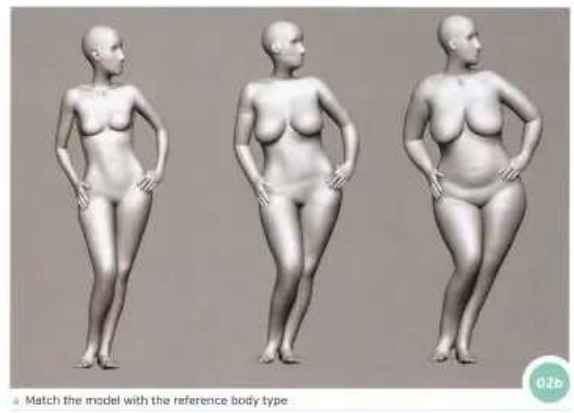
Curvaceous body types vary from person to person. From our reference, which you can see in fig.03 on the next page, we can observe that our model has curves and a sensual silhouette, just a little exaggerated. Some people don't have these shapes, but they are perfect for our purposes.

01: Posing

I'm using a base mesh here, but there are many different ways to start posing your model. You could start from scratch using a sphere, box, or cylinder, then pull and push shapes until you get the desired pose.

You could also start with a final base mesh and just get straight into posing, but the base mesh must have the topology carefully made. The face, hands, and feet will need a higher density, because they receive a lot of detail that requires a higher number of polygons.

You should use the method that you feel most comfortable with; there is no right or wrong way at this stage. To begin, my advice would be to first focus on the movement of the hips and legs, then the torso, and then worry about posing the arms and head afterwards.



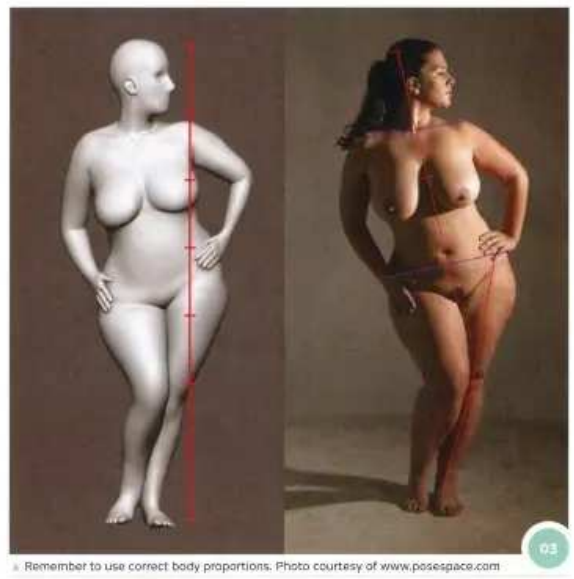
02b

▲ Match the model with the reference body type

02: Contrapposto

Before you start the *contrapposto* (counterpose) stance, you'll need to match the body type to the reference image. *Contrapposto* is a matter of balance, finding the weight distribution, and defining the "chief line" (fig.02a).

Pay close attention to the supporting leg here; check if the weight is totally on one or is it balanced between both legs? In our reference image we can see that the weight is mostly distributed on the left leg. You should also add some opposing lines by adjusting the orientation of the shoulders, knees, head, and so on (fig.02b).



03

▲ Remember to use correct body proportions. Photo courtesy of www.posespace.com

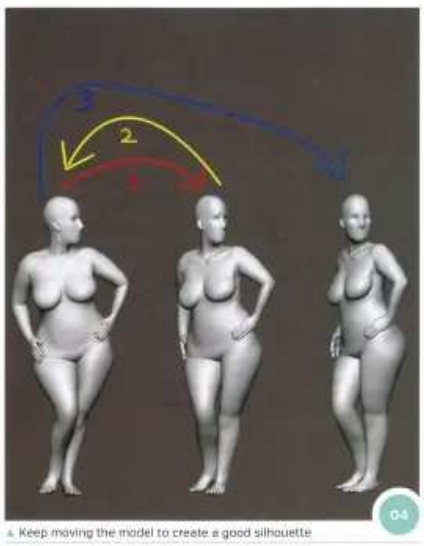
03: Proportions

I like to use proportions that are based on the idea that the female height is approximately seven head lengths from head to foot. Some sculptors use seven and a half or even eight heads, which gives the figure more power. I like to stick to seven though in order to ensure the figure appears soft and feminine.

The measurements can also be of relative proportions distinctly unique to the model, for example the leg could be the length of the torso. This is a very personal decision and you should find what works best for you.

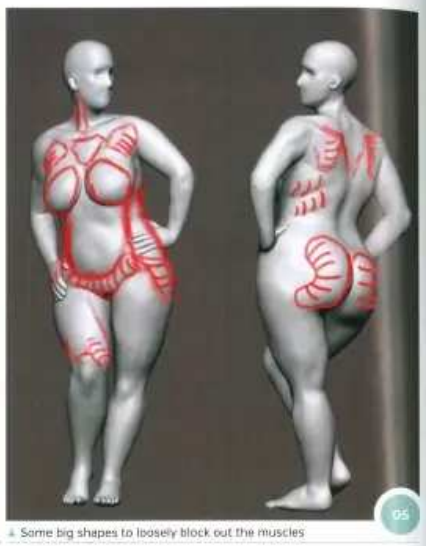
There are other, more mathematical, methods to work by, for example the distance from the iliac spine to the top of the patella is equal to the distance from the pubic line to the top of sternum; there are three head lengths from the acromion to the first index finger.

Finding the bony landmarks can be difficult in a fuller figure. The best way to find the fat covered landmarks on this model, especially on the hips, is to look for the silhouette and volume of the greater trochanter, the iliac spine, and the clavicle/sternum.



04

▲ Keep moving the model to create a good silhouette



05

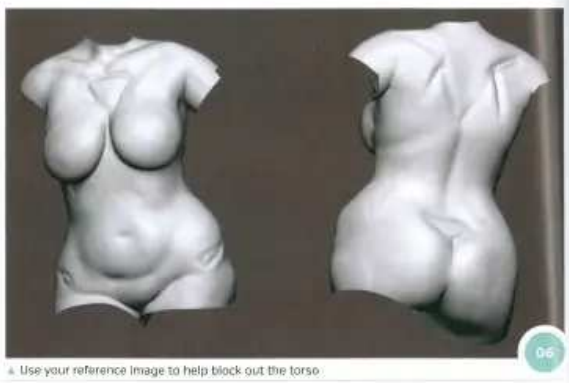
▲ Some big shapes to loosely block out the muscles

"I find it best to concentrate on sculpting the volumes that I see and try to make the sculpt harmonious and organic"

04: The silhouette

When I sculpt, I like to think of the forms to try to understand what I see by recreating the same volumes without losing that natural look. Basically I copy what I see, but use anatomy as the basis so I can understand what is going on. I like to think of anatomy as a language, which helps you translate the reference and visualize it better.

The silhouette is a vital part of the process. You should always focus on the silhouette – it is not something that should be worked on once, then forgotten; process all the way round. This creates the best silhouette for the model.



06

▲ Use your reference image to help block out the torso

organic. Now is a great time to recheck that the silhouette looks good!

07

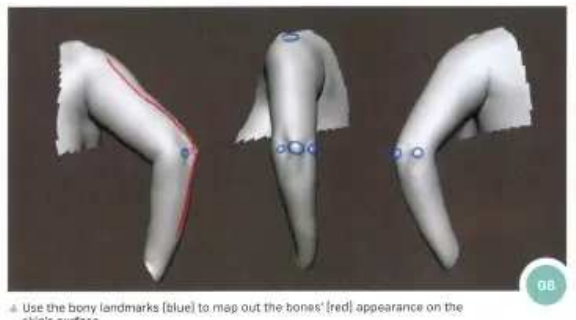
▲ It is important to give a natural feel to the breasts and buttocks

is very hard to see, but also has to be considered and understood as the basic underlying structure that influences the overlying skin and muscle contours.

It is easier to see the anatomy on the back of the torso. The trapezius and scapula are very visible, and those alone give us enough information to place the first shapes if we follow the chief line as the line of the spine.

07: Breasts and buttocks

Neglecting the breasts and the buttocks creates a stiff and unfinished feeling about the sculpture. You should therefore pay close attention to these areas. The breasts should be thought of as two oval shapes, inclined toward the center of the sternum.



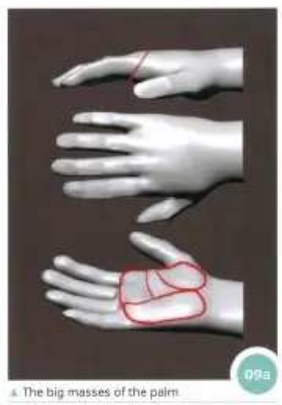
08

▲ Use the bony landmarks (blue) to map out the bones' (red) appearance on the skin's surface

PROTIP

View from below

The bottom view is an important one in this step because it helps give the exact shape and look of the breast sitting on top of the rib cage (see middle section of fig.07).



09a

▲ The big masses of the palm

09b

▲ Female (left) and male (right) hands

The gluteus muscles, especially on females, are bean-shaped. Looking up from underneath, the center of both sides should be the highest part.

by the silhouette alone – if it doesn't feel

the middle finger is the same length as

you need to pay attention to it all the time, even on the final touches. I have found it useful to mimic the silhouette from one angle, then spin the model 15 degrees and work on the silhouette again from this new angle. Then go back to the original angle and rework; then spin your model 30 degrees and repeat this

05: Blocking big shapes

When you are happy with the silhouette, we can start on the internal anatomy – the big masses. You don't need to worry too much about muscles and bony landmarks here. I find it best to concentrate on sculpting the volumes that I see and try to make the sculpt harmonious and

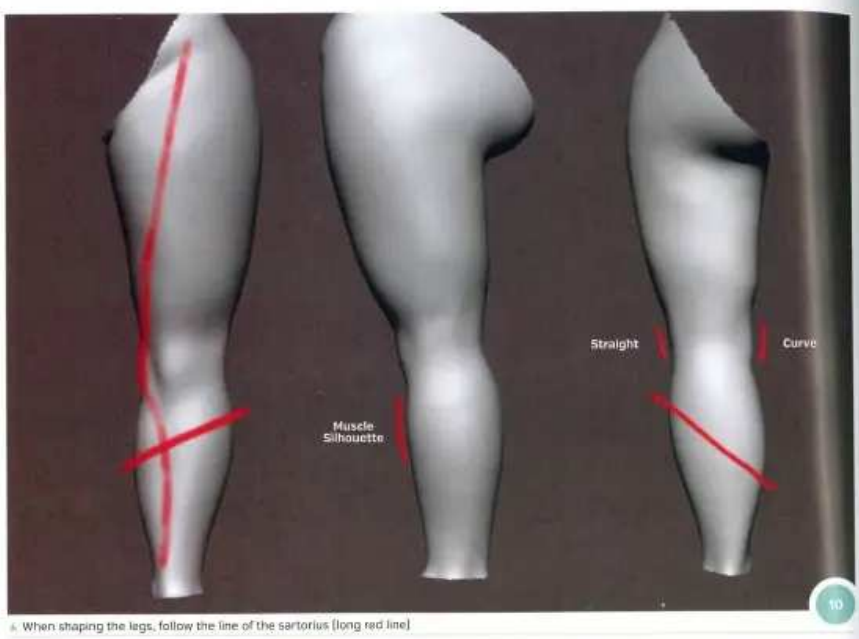
06: Blocking the torso

At this stage I focus and work on the torso. The front of the torso on the reference is very subtle but we have some key things to work on like the manubrium (the triangular shape at the top of the breast bone) and the iliac spine (on the hips). The rib cage

like an arm just looking at the silhouette, something is wrong and must be checked. Find the bony landmarks, such as the acromion and the olecranon to start.

09: Starting the hands

Don't neglect the hands – this is a mistake some artists make. Keep in mind that the palm. Also pinpoint the high point on the knuckle and the bottom fold from the profile of your reference; note the big masses of the palm (fig.09a). Research the differences between the male hand, which is more flat and square, and the female hand, which is more elongated, thinner, and rectangular (fig.09b).



▲ When shaping the legs, follow the line of the sartorius (long red line)

10: Starting the legs

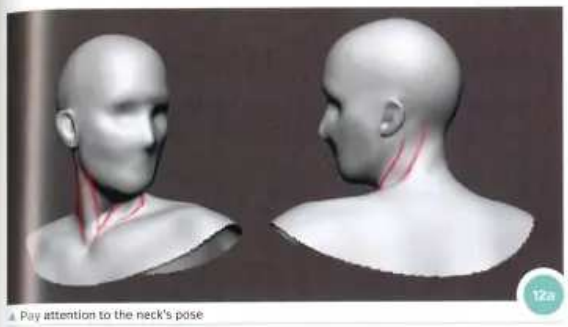
To start the legs, you need to find the line of the sartorius and use that as a guide by following it down to the tibia curvature. This curvature is really important to give a natural movement to the leg. The bent right leg uses the same process. On the knee, the patella has an important function with regards to the surface and needs attention.

Again, you should be able to see the nature of the leg by its silhouette alone – the same as with the arms – especially at this rough stage.

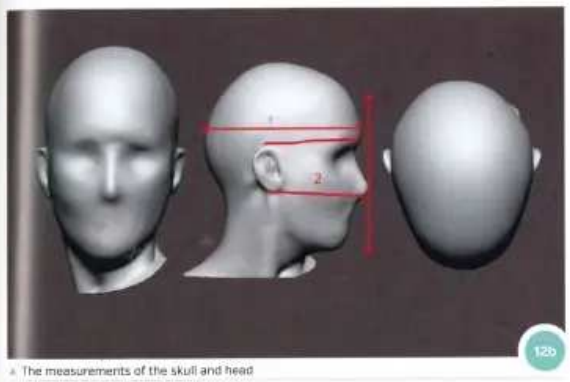
11: Starting the feet

The feet are similar to the hands and must be at least indicated at this early stage. There are some things to consider when tackling the foot. First, the big toe is shaped like a snake's head and the pinky toe should end on the same line as the base of the big toe. Note the protuberance of the 5th metatarsal on the side of

▲ Pay attention to the overall shape of the foot



▲ Pay attention to the neck's pose



▲ The measurements of the skull and head

the foot and the shapes the calcaneus makes on profile. Also note the opposing lines that the malleolus (ankle bones) have; the medial malleolus on the inner ankle should be higher than the lateral.

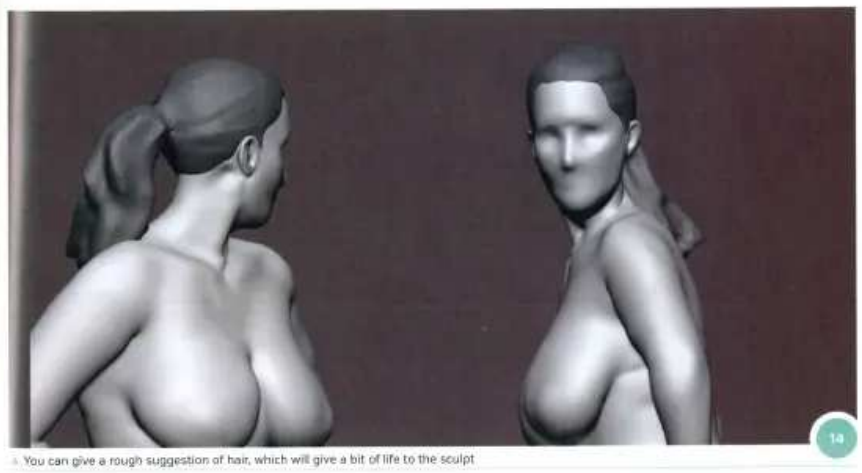
12: The neck

The neck is all about gesture; the sternocleidomastoideus has a big influence on the shapes here as the head is looking to the side (fig.12a). The direction of both should be at least indicated here.

There will be a lot of information and detail on the head, but for now we only need to know some basic measurements. First, from the chin to the top of the head is the same length as the back of the head to the tip of the nose. The ear should be indicated early to help you see the shape of the head and should be placed between two lines crossing the eyebrows and another on the base of the nose. The nose is about level with the ear line (fig.12b).

13: Indicating the hair

Hair is very complex to sculpt, but for now we can place and sculpt it in roughly, just to give an idea of the flow and movement. You can pay attention to the silhouette to form the outer shapes of the hairstyle and then fill the internal information in.



▲ You can give a rough suggestion of hair, which will give a bit of life to the sculpt

Curvy female

Part 02 | Refining

By José Péricles

Freelance digital sculptor

In this part we will explore the female anatomy in more depth and start to use observation more to make the sculpture really stand out. This is a critical stage because we are getting closer to what the final model will look like.

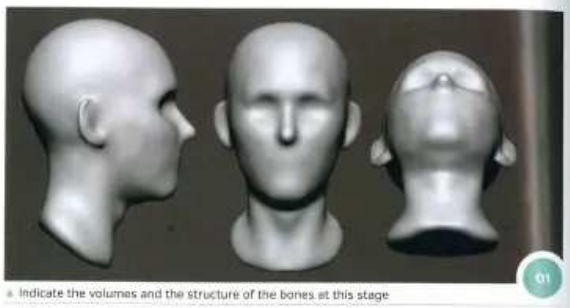
01: Blocking the head

You should always keep in mind the forms of the human skull and how its structure influences the shape and look of the face. It is important to have a head that looks solid and has a good foundation before you start to sculpt the facial features.

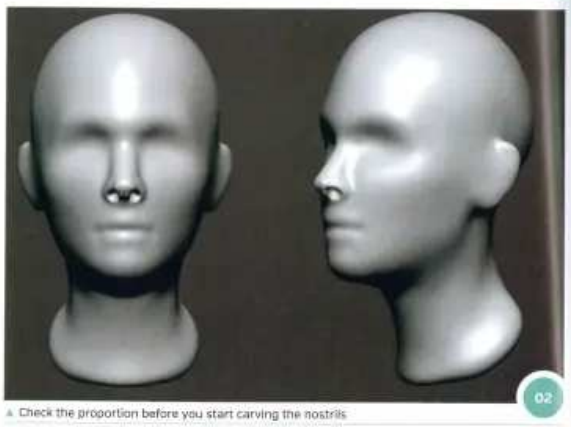
It is a good idea to have a rough suggestion of the zygomatic and frontal bones, eye sockets, nose, and the ears, as this will help with refining later. The ear can help to give you a better idea of the proportions of the head and therefore should be one of the first features to be mapped out – but the last to be sculpted in detail.

02: Starting the nose

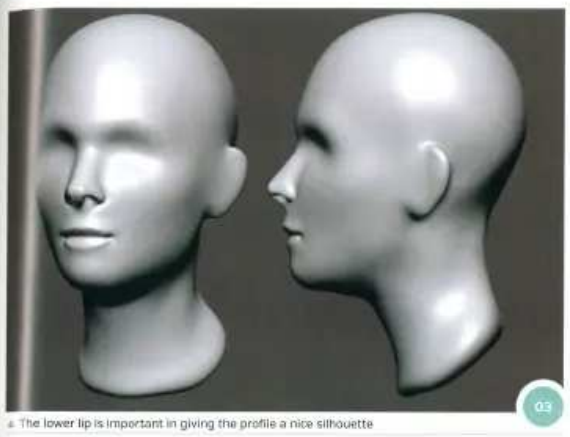
The first step is to roughly sculpt the nostrils. We do this by putting two holes below the wings of the nose. It is important to make sure the holes are visible in profile. Pay close attention to the nasolabial fold and refine by giving a rounded shape to the wing of the nostrils. We can also sculpt and give shape to the bridge of the nose; be sure to check the



▲ Indicate the volumes and the structure of the bones at this stage



▲ Check the proportion before you start carving the nostrils

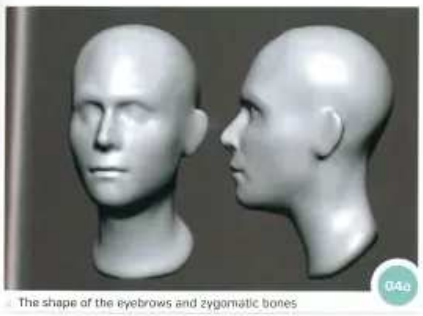


▲ The lower lip is important in giving the profile a nice silhouette

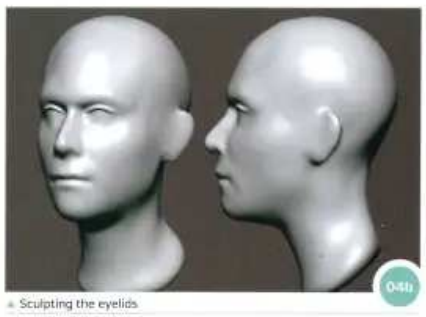
(see step 01) before you can start to sculpt them. It really helps to have the proper shapes of eyebrows and zygomatic bone before starting the eyes (fig.04a).

It is important to understand that the shape of the human eye is not an oval but is shaped more like an asymmetric leaf or teardrop. The highest point on the upper lid is closer to the midline of the body whereas the lowest point on the lower lid is closer to the sides (fig.04b).

When looking at the face in profile, the lower eyelid should always be deeper than the upper eyelid (fig.04c). The lateral corner of the eyelid should be higher than the opposite one on the frontal view. Always make sure your eyeball looks like a sphere.



▲ The shape of the eyebrows and zygomatic bones



▲ Sculpting the eyelids

appearance of the bone on the surface.

03: Starting the lips

When sculpting the lips, it is a good idea to keep in mind a cartoony heart, but with a more rounded bottom and slightly pointier top curves. When building the upper lip it is important to think about what it will look like in profile so that you can give the mouth a more realistic look.

You should try to make the corners of the lips deeper than the front, which helps to create a nice fleshy appearance. Lightly sculpt in the bottom lip and make sure you show the influence of the chin bone and muscles.

04: Adding the eyes

You should already have the basic structural area of the eyes mapped out

Asymmetry of the eyes; note that the lower lid sits deeper than the upper lid

"Observation of reference images can mean the difference between a stiff generic sculpt and a natural realistic one"

05: The skull

The skull is something that needs to be checked at the very beginning. However, I want to point out a few things here that should be given more attention, such as the general shape of the forehead and skull.

The skull should be bigger on the back (looking from a top view) and the forehead must have the correct shape – it cannot be flat. It is always good to remember that nothing on the human body is purely flat.

06: Refining the lips

Now we can add volume and shape to the lips – this is pretty straight forward. The top lip has three shapes, one on the center and two larger ones on the sides. The bottom lip has two big ones, split down the middle.

The shapes around the mouth are just as important as the lips, especially a rounder mass at the corners of the mouth and the contours of the bottom lip and chin.

07: Refining the nose

When refining the nose, it is very important to use observation and reference. You should look from the bottom to properly shape the nostrils, which look a little like a bean. The tip and wings of the nose must be defined to give a realistic appearance. It is important to make sure you sculpt the philtrum as accurately as possible [fig.07a, fig.07b].

08: Refining the ear

Since you already have the overall shape of the ear, you should now focus on the negatives of the helix [fig.08a] and the concha. Don't forget to look from behind and check with the reference for the proper shape. Put some love into it to try to get a proper thickness on the ear. Many good sculpts can be ruined by bad ear modeling [fig.08b].

Pay attention to shapes and check every angle

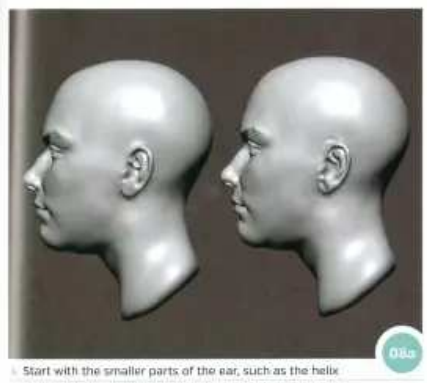
Start by giving definition to the lips by working on the shapes around the mouth

The important masses of the nose

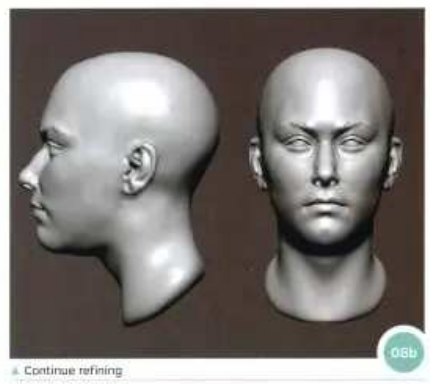
09: Refining the torso

Observation of reference images can mean the difference between a stiff generic sculpt and a natural realistic one. The way you approach the torso should be similar to the blocking of the head: start with big shapes but pay attention to their influence on the silhouette and the internal information. I find lighting the model from the very top useful as this gives deeper shadows than other angles, which helps with accurate sculpting and avoiding carving mistakes. You should also be delicate with the intensity of your brush. To keep myself focused I isolate the area I am working on and ignore the unrefined parts [fig.09a, fig.09b].

Use soft shapes to give a natural feeling and look at the nose from the bottom



Start with the smaller parts of the ear, such as the helix



Continue refining

Begin refining areas such as the navel and nipples

Continue to refine and give some indication of the skin folds

10: Refining the back

Refining the back is similar to refining the torso. However, there are more areas to pay attention to, not just the back itself. To achieve a well-defined back you need to work on the shoulders, back of the neck, and gluteal muscles [fig.10a, fig.10b].

11: Refining the arms

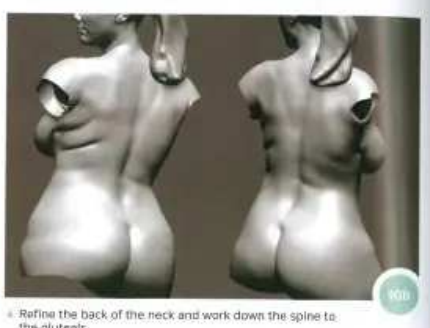
The arms can be tricky to get right so you should therefore keep your anatomy in mind to help you to make them more accurate.

At the same time, it is important to understand that 90% of what makes an arm sculpt look good is its silhouette. When you are working on the internal shapes then, always think about what the silhouette looks like – it doesn't matter if all the muscles are in the right place if the arm looks like a cylinder [fig.11a, fig.11b]!

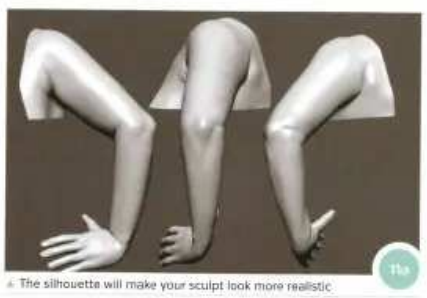
12: Refining the legs

To refine the legs you can use the same fundamental process that we used for the arms in the previous step. What you should keep in mind though is that you need to be very careful and leave almost everything as just an indication on the leg. As the model is an curvy female, the contours are very soft and the meeting of the skin on some areas is very creased [fig.12a, fig.12b].

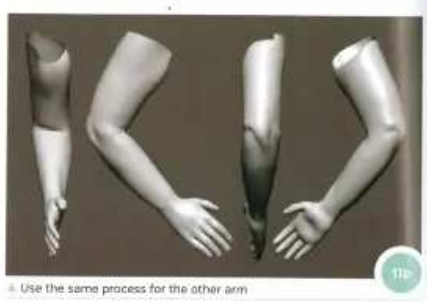
Start blocking the trapezius and scapula but also pay attention to the sacrum area; it is an important area of the female back



Refine the back of the neck and work down the spine to the gluteals



The silhouette will make your sculpt look more realistic



Use the same process for the other arm

The sternocleidomastoid on the silhouette and the trapezius

Be precise with the insertion and origins of the muscles

PROTIP

Use the silhouette

I can't stress enough that the silhouette is key to a good final model; you don't need lots of anatomical knowledge because observation and reference play a bigger role.

13: Refining the neck

The neck is quite twisted in this pose so understanding anatomy here is crucial. As always though, pay attention to the silhouette. Look at how the trapezius moves down the back of the neck and the prominence of the sternocleidomastoid muscle [fig.13a, fig.13b]. When a head is so twisted like that, the submaxillary gland pops out.

14: Checking the body

Look at the model as a whole once you have the areas refined and start to check on the proportions to see if everything works together. Now is a good stage to move things around and refine the silhouette or particular areas if you feel the need to. Remember that a good sculpture needs to have a nice look from every angle; even look from the top to the bottom.

12a

On a fuller figure leg, you need to make sure you don't make the bony landmarks of the knee too visible

12b

I sculpt a standard knee in order to be anatomically precise, but it will become very soft later

14

Check the proportions and silhouette from every angle possible

Master projects

Curvy female

Part 03 | Adding further detail

By José Péricles

Freelance digital sculptor

This is the final part and it could be the hardest one, especially if you haven't put all your effort into making a really good-looking sculpt. In this part we will look at the hair, hands (including the fingers and nails), and feet in great detail. Most artists ignore some of these because they think they know them already, but that could destroy a good model!

01

Concentrate on the style and silhouette then refine the details, but keep simple for now

01: Blocking in the scalp hair

For this first step we can focus on the hair's general shape and silhouette. We just need to indicate the hairstyle and flow of the hair; we can ignore many of the finer details of the structure at this stage.

"The hair should feel natural and like it is part of the sculpture, rather than just something that is stuck on top of the sculpture"

Once you have blocked in the direction of the hair's flow you can begin to refine the details of it, but make sure you don't damage the overall silhouette.

02: Refining the scalp hair

I will point out now that you will need a lot of patience at this point because good hair requires lots of back and forth! I don't think it is possible to make decent hair quickly. The hair should feel natural and like it is part of the sculpture, rather than just something that is stuck on top of the sculpture.

03: Finalizing the scalp hair

For this step, you should try to keep in mind that you will be focusing on smaller details with every pass now; however, you should avoid adding too many individual of strands of hair. You don't want the hair to be super detailed; it should be subtle to give a freshness to its appearance.

02

Now start to put some negative values and then add smaller details between the contours

03

Notice the subtle strands of hair, which give more randomness to the hairstyle

04

Indicate the hair flow and refine the sections

05

Soften the transitions and smooth the hair

04: Blocking in the ponytail

The concept for the ponytail is basically the same as for the scalp hair, but should be more focused on the silhouette and sections of hair. Pay attention to the direction and flow of the hair. It should indicate some randomness but be careful not to make it too chaotic.

Focus on first giving the hair sections, then work their silhouette and then further refine each end of the sections (keeping the hair flow). You should also indicate a smooth transition between the sections, keeping in mind the silhouette.

05: Refining the hair

Now you should start to refine the sections themselves, taking away the definition and dark values of the hair. The transitions between the different sections should be subtle and soft. Remember that it should feel natural and not resemble action-figure hair with all strands carved deeply into the sculpture.

06: Finalizing the hair

The end of each strand and section must be indicated; a strand of hair should not suddenly end and another one should not suddenly start. These transitions help us to avoid unbelievable hair, even if it looks random or messy.

06

Give the end and start of each section some definition

07: Fingers

The silhouette of a finger usually has pronounced knuckles, but since we are sculpting a large hand, the phalanges will generally be rounder and more pronounced (but go in slightly) at the knuckles.

Remember that realistic fingers have a cylindrical shape and that the fingernails are convex, so try to avoid flat nails. Repeat this for all the fingers on both hands.

08: Thumbs

The process of sculpting the thumb is very similar to the fingers, but you must remember that thumbs only have two phalanges. This changes the overall look (even on a fleshy thumb) and you should at least indicate the first knuckle (fig.08a, fig.08b).

09: Hand and palm

It's important to note that the direction of the fingers is crucial to a natural-looking hand – they should all converge and curve towards the middle finger (the only straight one). The length

07

The fingers are slightly larger on a curvaceous model

08b

The final refined thumb

09

Notice the curvature of the fingers

of the middle finger should be the same as the palm. Pay attention to the bulge of the big muscle between the index finger and the thumb.

10: Refining the hand

Now you need to show just a suggestion of the knuckles, tendons, and folds of the skin between the fingers in order to give a natural look to the hand. This effect needs to be very subtle though because you don't want the hands to look strange.

▲ The thumbs require a similar blocking process to the fingers

▲ Finalized hand

"The key to sculpting the foot of a curvy person has very little to do with anatomy; you should instead use the overall silhouette to get a good look. Ensure you get the proportions right though"

11: Toes

Sculpting the toes is similar to the process for the fingers, but they are more bulbous on the last phalanx (fig.11a).

The same concept is valid for the pinky toe, although the silhouette of this is key to avoiding mistakes with its size and shape because it is so compact and small (fig.11b). The big toe is sculpted in the same way but it is much bigger than the other toes (fig.11c).

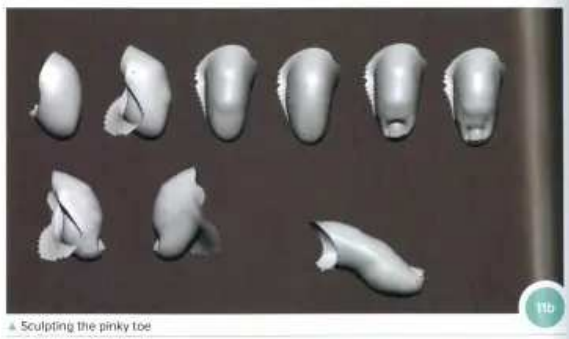
▲ The shapes of the middle toes

12: Finalizing the foot

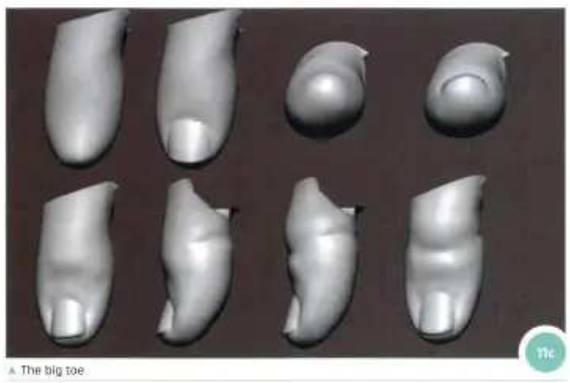
The key to sculpting the foot of a curvy person has very little to do with anatomy; you should instead use the overall silhouette to get a good look. Ensure you get the proportions right though.

The correct proportions of the foot should be three thumbs from the ball of the foot to the heel and the tip of the pinky should be in line with the base of the big toe.

You can seen my final full-body figure on the right-hand page here, both from the front and from behind.

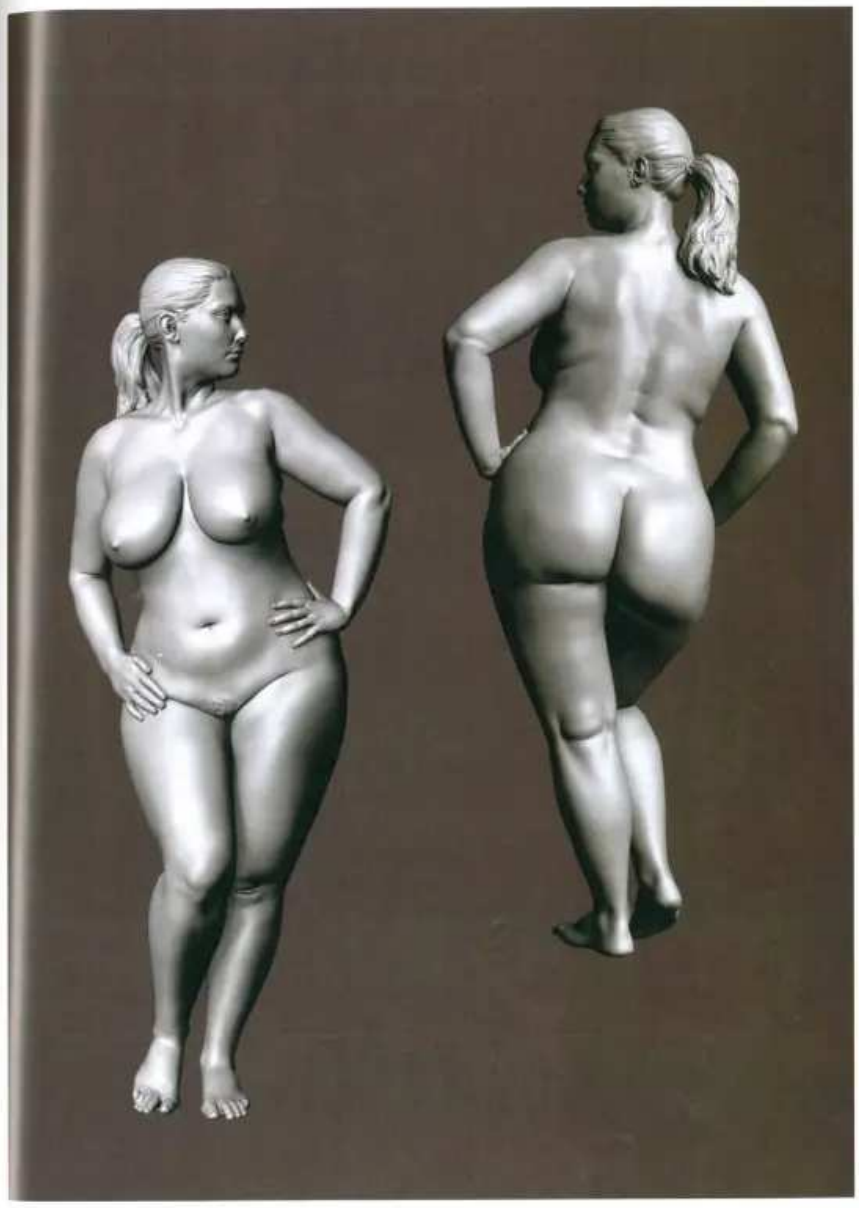


▲ Sculpting the pinky toe



▲ The big toe

▲ Notice the proportion and the smooth contours



Master projects

Slim female

Part 01 | Basic blocking in

By César Zambelli

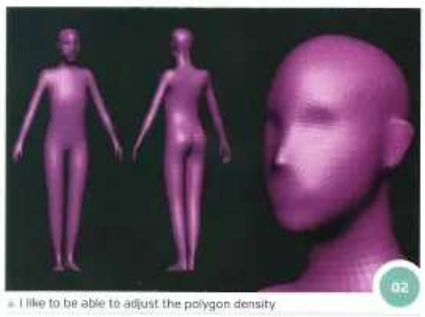
Digital sculptor

In the first part of this chapter we will work through the key principles behind blocking and posing. We will model an underweight female figure and discuss how best to represent the underweight form using the base mesh, blocking and posing process.

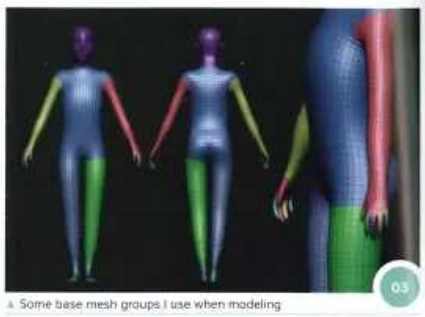
01: Starting with the base mesh

To start off, we're going to use a base mesh. There are lots of ways to begin a model but, in my opinion, the base mesh is the best way to go for a full-body model. Some other options to consider are ZBrush's DynaMesh or ZRemesher, or Mudbox's retopology tools, but you have greater control over your topology by using a base mesh. You can use UVs to create mesh groups and easy selections.

▲ A model I made previously using the same base mesh



▲ I like to be able to adjust the polygon density



▲ Some base mesh groups I use when modeling

02: Base mesh topology

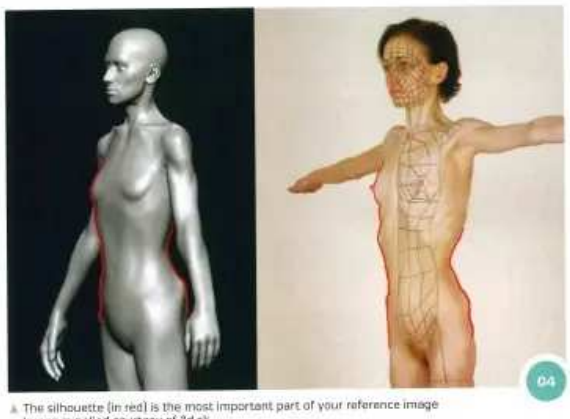
For me, the most important thing about using a base mesh is the ability to place want to have a higher density for detailing. For example as you can see fig.02, I add

I don't make the eyes and mouth with the topology (aside from the extrusions for the ears and nose) so I have more freedom to sketch and place features where I want.

03: Preparing the base mesh

I also prefer to add UVs to my models before sculpting. It may seem odd to use UVs for sculpting, but they actually speed up my process a lot. When you're sculpting a complicated pose, you often have to hide and unhide parts of your model, for example to hide a hand that's in front of the torso or to isolate the fingers. Instead of selecting individual polygons then, I make groups of selections to make it easier to manipulate individual parts of the mesh.

I use my UV shells to group and regroup whenever I want; with the click of a button I can have all my groups available again. This helps me a lot throughout the entire modeling process.

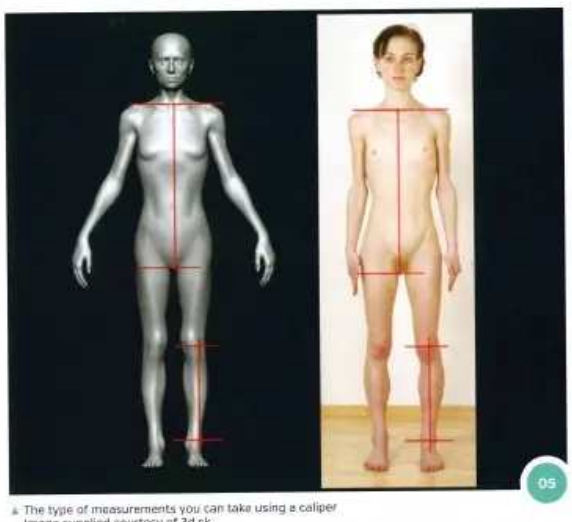


▲ The silhouette (in red) is the most important part of your reference image
Image supplied courtesy of 3d.sk

04: Using a reference

Now the base mesh is prepared, we can begin modeling. When modeling the human form, the most important thing to know is how to use references in the right way. It's very common to see people losing their focus due to the amount of detail that the reference offers, and that's one of the greatest mistakes that can happen for a modeler. You have to understand that, as cliché as it sounds, less is more! Of course detailing is important and plays a big role in the overall realism of your model, but *structure* is what really gives a natural, realistic feel to your model.

When copying a reference, the silhouette is the only thing that's important in the major part of the sculpting process. In the ideal world, you'd have a 360-degree shot of your model and copy each silhouette



▲ The type of measurements you can take using a caliper
Image supplied courtesy of 3d.sk

There are two ways of doing this. The first

and it's ultimately easier to pose.

I always use the same base mesh for my models. Even if I start a sketch with DynaMesh, I transfer the details to my base mesh if I want to continue the sketch.

the polygon density as you wish. When using automatic topology tools, the mesh tends to end up with the same density over all (even with ZRemesher control painting, I find that I don't have proper control over what's happening). In places like the face, ears, hands, and feet, you

with a higher density than the torso.

I also prefer to use a smooth brush rather than edge loops for sculpting. This is because the topology plays a major role when you are smoothing, and that makes a lot of difference. This is also the reason

until the model is done. It takes a bit of time to get the hang of it, but when you do, you'll see how much easier it becomes to interpret a reference.

05: Measuring your reference

Taking measurements of your model by placing a caliper on your screen

may seem odd, but it does in fact work, believe me! My figure-modeling master is a traditional sculptor and started to use ZBrush without knowing anything about computers or the software. When he uses references, he simply places the caliper over his screen and measures the picture and the model.

is to adjust the zoom on your model so it's the same size as the photo, and then you can compare the two sets of proportions. The second and safer way is to make comparative measurements: for example, measuring how many noses the head is in width, and comparing that to your model.

06: Fixing the proportions

For me, measuring the proportions is always a bit tricky. I always work with references and try to make them look more realistic than idealistic. It's hard for me to use measurements like the "eight heads" system because a real human always varies. I prefer to copy the measurements of the reference that I'm using, and have the proportions in mind as a guideline, not as a rule. That being said, there are some general proportions that I try to keep in mind:

- the distance from the trapezium to the nipple, the nipple to the navel, and the navel to the end of the torso at the crotch, each equals one head measurement;
- the width of the palm is the same as the distance from the base of the nose to the end of the chin;
- with the arms relaxed, the navel is a bit lower than the elbows, and the wrist is aligned with the end of the torso;
- the feet are the same length as the head;
- the nipples align with the iliac spine.

07: Blocking out the model

I like to start my model by laying out the main proportions of the body, and always start by laying out the main bony protrusions of the head and the torso first. The female that we are using as a reference is very thin, so it's a bit easier to look for protrusions here.

I place the clavicles, scapulae, and heads of the humerus at the shoulders. Remember that the clavicles have an "S" shape – don't make them straight. I also make a very simple head block. Since we're using the proportions of the head as guidance, I think it's good to have something laid out, so you don't get lost with your other proportions.

08: Hip protrusions

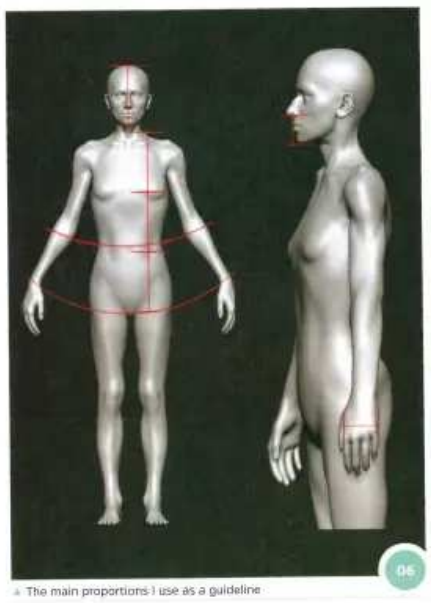
I continue laying the protrusions and main shapes of the torso, and begin to fill out the ribs, abdomen, and hips. For me, the hip area is one of the most difficult parts of the body to model; if you misplace its structure the model will always look odd.

As 3D modelers, we get into the habit of always modeling a T-posed character, so we don't usually see the hip area as a problem – but when you start to fashion your models in more complex poses, you realize how hard it is.

To block the hip correctly, you must first understand its bone structure. The best landmarks to mark in are the posterior and anterior iliac processes; once you place the four protrusions (two on each side of the body), you have defined the hips.

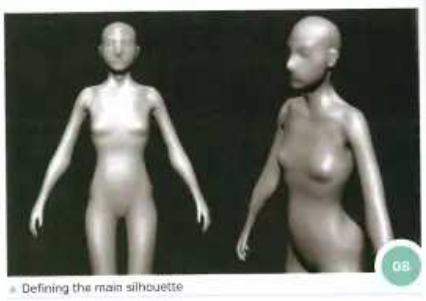
09: The lower body

I start the first blocking of the legs. I use the anterior iliac spine as a starting point (as it's the origin of the sartorius) and add the center part of the quadriceps, the rectus femoralis. The sartorius is important because it will divide the



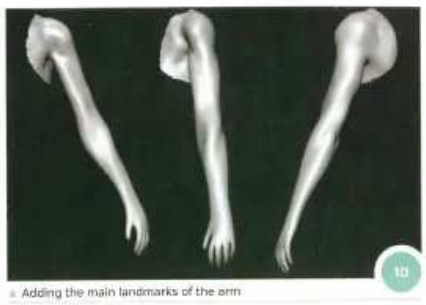
▲ The main proportions I use as a guideline

▲ The proper placement of protrusions on the back and torso



▲ Defining the main silhouette

▲ Adding the main landmarks of the leg



▲ Adding the main landmarks of the arm

front part of the thigh into two groups: the extensors and the adductors.

I also work a little on the knee, placing the patella and the head of the tibia. The shin is composed of two bones, the tibia and fibula. The tibia is the main one. You should always remember that it has a curve when viewed from the front. I also place the gastrocnemii (the calf muscles) that stretch from the condyles of the femur to the Achilles tendon.

PROTIP
Model in stages

I like to model the human body in a particular sequence: first the torso, then the head, legs, arms, hands, and feet. That said, I always keep them at the same stage within that sequence: I block the whole model, then I refine the whole model, and so on.

You should never completely finish one part of the model while other parts are still at an earlier stage. If you do that, your model could end up looking like Frankenstein's monster, with parts that don't relate to others as well as they should.

10: Sculpting the arms

Now we need to block out the arms to get them to the same stage as the other parts. As usual, we use the bony protrusions as the first points of reference: the head of the humerus and the humerus' condyles. The elbow is a hinge joint, so when you place both condyles of the humerus, the axis of the elbow joint helps you with posing.

From the shoulder, we can then block in the deltoid, making sure you make the biceps come from under the deltoid and link into the forearm bones. The triceps also emerge from under the deltoid and its three heads unite in a large tendon that attaches to the ulna.

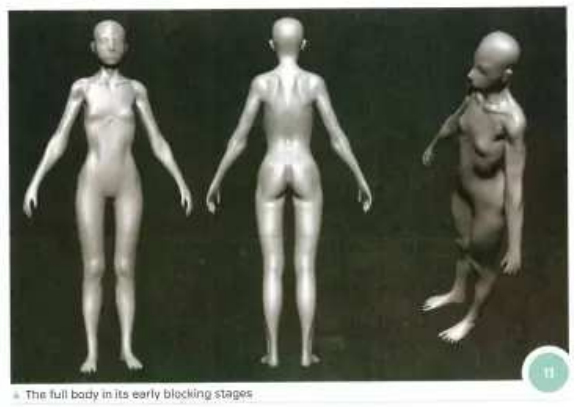
> "The good thing about digital sculptures is that we can fix the proportions at any time"

The humerus' condyles are also important because they're the origin of the flexors and extensors of the hand. The flexors originate from the medial condyle and the extensors from the lateral condyle.

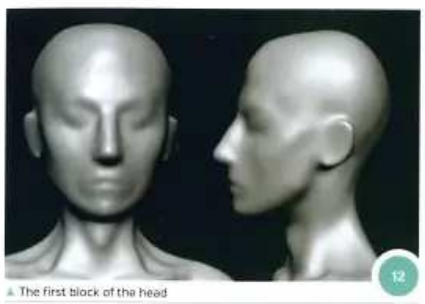
11: Recapping our progress

This is the full body at its first stage of blocking. You'll notice the main bony protrusions (the clavicles, the heads of the humerus, edges of the scapulae, iliac crests, knees, condyles of the humerus) and should be able to see that the whole body is at the same level of detailing, which is very important.

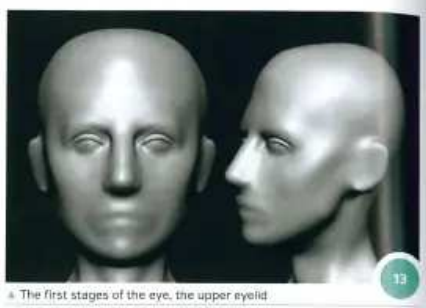
The good thing about digital sculptures is that we can fix the proportions at any time, which is impossible to do with real clay. I like to start looking more carefully at the proportions now because, for me, it's easier to analyze the proportions when I have the basic features placed.



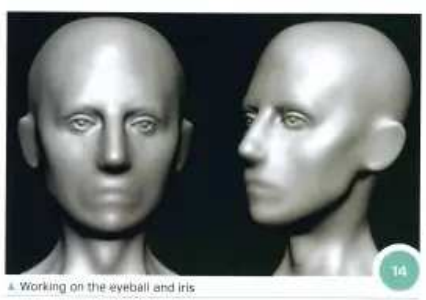
▲ The full body in its early blocking stages



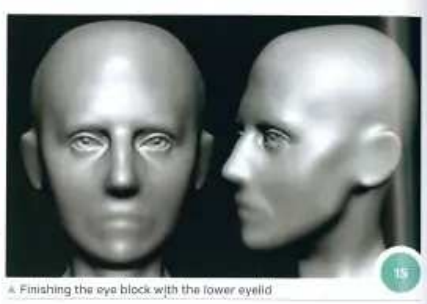
▲ The first block of the head



▲ The first stages of the eye, the upper eyelid



▲ Working on the eyeball and iris



▲ Finishing the eye block with the lower eyelid

> "The secret to making a good eye is to properly place all of its surroundings too"

12: The proportions of the face

Fig.12 is a close-up of the head. The head is the only part of the body that I advance a little bit more than the other parts, because it's very hard to block it in once the model is posed.

After this first block, I start to work on the eyes. The secret to making a good eye is to properly place all of its surroundings too (the cheekbone, eyebrow ridge, bridge of the nose, and so on), otherwise it's impossible to ensure

eyelid and the eyeball. You have to make sure that the upper eyelid has a proper curvature when viewed from underneath, and also keep in mind that the outer corner of the eye is usually higher than the inner one. A common mistake I see is when the inner corner of the eye misplaced; it's deeper than people usually imagine it.

14: The eyeball

The next step is to work on the eyeball itself, making sure that is round as it should be. The volume of the eyeball directly affects the silhouette of the eyelids, so if you're doing a model like I am, without using actual spheres,

creating the actual irises, we'll fill these in and make new ones with more care.

15: The lower eyelid

The final step for the eye blocking is to add the lower eyelid. Now you'll notice how important it is for the eyeball and its surrounding structures to be properly placed. If they're in the right place, making the lower eyelid is very easy; you just use a flat brush and add a layer of volume.

It's important that you don't create a big depression under the eye if the person is young because it will make the model look very old. I see a lot of students making depressions and wrinkles way

16: Checking the eye proportions

Fig.12 demonstrates another angle to show the eye curvature from the bottom. Notice that you don't a see a corner on the brow bone, and that it's narrower than the cheekbones. If you make the brow bone the same width as the cheekbones, the model will probably look very masculine. As well as checking the proportions, I also work on the nose a bit, defining the wings of the nose and working on the tip cartilage.

> "Personally, I think you can tell if an artist is a good or bad modeler just by looking at the model's ears"

17: The mouth

I work on the mouth in the same way I did the eyes: fixing all its surroundings first and then working on the upper lip and lower lip. Women tend to have smaller and thicker mouths than men, but this is a general rule – good to use if you want to make a pinup-style woman. However, the model that we're working on has a slightly wider mouth.

The upper lip is divided into three main volumes: a middle bump and then one bump on each side. The lower lip has only two bumps, one on each side, making a depression in the middle.

18: Starting the ear

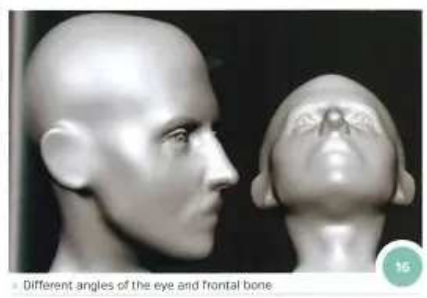
Now it's time to work on one of my favorite parts of the body: the ear. Personally, I think you can tell if an artist is a good or bad modeler just by looking at the model's ears.

I lay out the silhouette of the helix, then the antihelix, and finally the hole for the concha. The depth of the concha is very important. People tend to make it way shallower than it really is, which affects the whole construction of the ear. The ends of the antihelix should go quite deep, but if the concha is shallow they will not have room to do so.

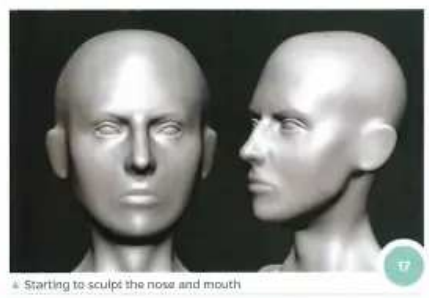
19: Blocking the ear

Now we'll block in the ear in more detail. When modeling ears, a common problem is that the side view works but the frontal view looks quite flat. This almost always happens because the concha is too shallow.

Note the depression between the antihelix and the antitragus, which is very important but often forgotten: people usually make the antihelix without any curvature from the frontal view. Of course the ear is a part of the human body that varies a lot, but most of the rules that I've mentioned work in the majority of cases.



▲ Different angles of the eye and frontal bone



▲ Starting to sculpt the nose and mouth

so on), otherwise it's impossible to gauge the final effect. I see lots of artists who just make a big hole before starting, but I like to add the volume of the eyeball beforehand, as if it's under closed eyelids.

13: Surrounding the eye

After I'm sure that the eyebrow ridge is properly placed, I add the upper eyelids. Here you have to make sure that the eyeballs are properly modeled.

When it's done, I like to make some concentric circles that indicate the iris and pupil, which is easier to do if the face is looking natural. Don't overdo it though because it's just a landmark at this stage. When we reach the stage of realistic wrinkles is to look at 3D scans. You'll see the actual model without skin color to influence your impression, and you'll notice how smooth and subtle the human body really is.

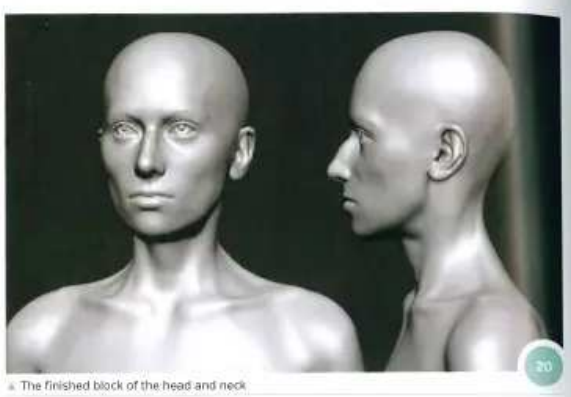
▲ Working on the auricle, helix, and antihelix of the ear

▲ The finished ear block with all its features

20: The neck

Now it's time to work on the neck. For blocking purposes, you can divide the neck in three groups: the throat, sternocleidomastoid, and trapezium. The throat is in the middle and you'll need to keep in mind that the whole neck doesn't go vertically straight down; viewed from the side, the neck always has an angle.

The sternocleidomastoid is a muscle that originates at the mastoid process, with one of the heads reaching to the sternum and another to the clavicle. The trapezium is the big upper-back muscle that stretches from the occipital bone, attaching to the clavicle, spine of the scapula, and acromion.



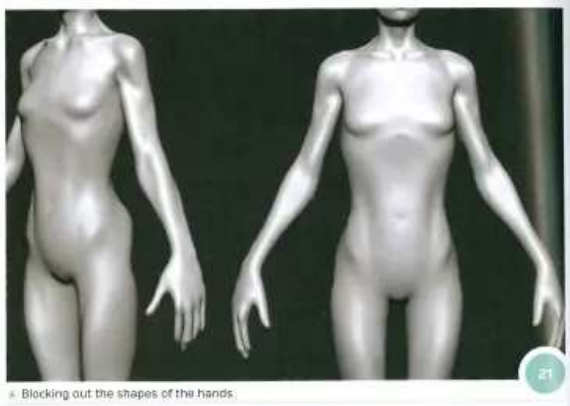
▲ The finished block of the head and neck

21: Blocking the hands

Before I pose the model, I also block in the hands. This is good to do at this stage, otherwise you will struggle with proportions of the hand and arm when you pose them later. Even though the hand is not as exact as it should be, it gives you an idea of the actual sizes of the palm and fingers, which is very important.

The proportions of the hands are easy. Treat the palm as a square – you'll find that the middle finger is the same length as the sides of the square. The index and ring fingers end at the nail of the middle finger and the pinky ends at the last phalanx of the ring finger.

Divide the finger in half to mark the first phalanx, then divide the last part in half again to make the second phalanx. Finally, divide the last part in half once again and you have the start of your fingernail. This works for all the fingers. You may also notice that female hands are longer, so the palm and fingers are a bit longer, but the finger division still works.

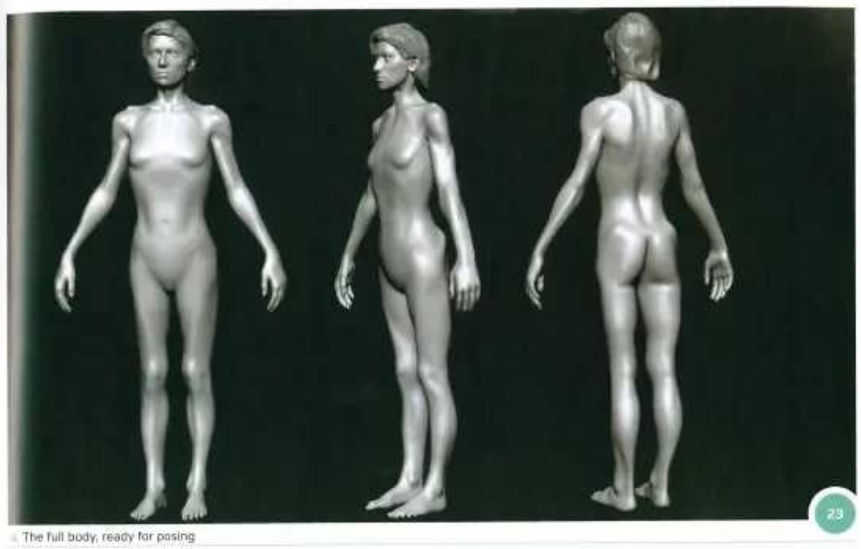


▲ Blocking out the shapes of the hands

22: Refining the back

Now we can refine the back a little further. You can see the two scapulae in fig.22, and how flat her trapezium is, as it shows much more spine than it normally would. The hip bone is also very visible, which it wouldn't typically be on a body of average weight. On the lower back, you can see the spine extensors attaching to the sacrum.

▲ The structure of the back



▲ The full body, ready for posing

23: Posing the model

You can see the finished block now in fig.23. We're ready for posing. The head is a little better detailed than the rest of the body, but that will help in the process, as I said previously.

While blocking, it's important to have the main proportions, main protrusions, and muscle groups blocked out ready for bending and posing the form. I don't like the standard T-pose here – I feel that the shoulders are very compressed. For me, a relaxed version works better.

Keep in mind that the model that I'm creating is very slim, so the bones are noticeable here but would not be as prominent on an "average" female figure; places like the buttocks, thighs, and abdomen have a lot of depressions and edges. On average, women are rounder and softer due to the amount and placement of their fat, so you would see fewer bones and much rounder forms than on our model.

▲ Starting to pose the model

24: Posing – first steps

This is the first stage of the posing process. As you can observe, having a low-poly mesh with decent topology makes my job much easier for this part of the process. This is the reason that I don't make the T-pose more detailed – it would mean that I would lose a great amount of work.

The posing process is very messy, but there are two ways to do it: you could spend a lot of time making a rig and painting the skin weights, or you spend less time fixing the deformations. If the pose is simple, I prefer the latter; if the pose is more complex and you have to experiment a lot, creating a simple rig in a package like Maya would make it work.

25: Refining the pose

At this is stage, everything is properly posed. I'm still using symmetry so the model is symmetrical, and in this case it works fine. In fig.25 you can see that the hip area, ribs, and shoulder are better blocked. Notice how much the head of the humerus projects from the surface; that's very important on this pose. Also note the position of the head and how difficult it would have been to block in at that angle.

Small breasts like these may vanish during the posing and smoothing process, so make sure you at least have the nipples placed, to keep a better sense of proportion.

▲ Fixing the limb positions

26: Refining the form in pose

This is the first stage of the posing process that is more defined than the T-pose block. I place the ribs, which are very important on a figure this skinny and even more crucial in a pose such as this. There's no secret to modeling the ribs – you just need a reference. Count them with a lot of care, place them correctly, and check the spaces and placement between them. We can also see better definitions of the biceps and condyles of the elbow in fig.26; remember that they look like this due to the lack of fat.

27: Key points of the pose

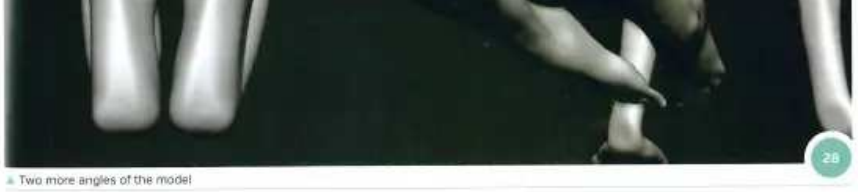
Fig.27 shows two other angles of the same stage, with a few more important points to take note of. First, never make the rib cage flat – always curve it protectively around the torso. The sartorius should also help divide the forms of the thigh. The condyles of the femur will contribute to the bigger mass of the knee, and then the patella, a little lower. Finally, note the compression of the scapulae and trapezium

28: More angles of the pose

Fig.28 shows our pose from another two angles. With this better view of the knee, you can see the condyles of the femur, the patella, and the head of the tibia touching the ground. Note the curvature and angle of the shin and feet and the curvature of the femur, which is very interesting on this model; due to the lack of muscle mass and fat it becomes very evident.

▲ Different angles of the model

▲ The details of the torso



▲ Two more angles of the model

Master projects

Slim female

Part 02 | Refining

By César Zambelli

Digital sculptor

In this part, we will take our posed model and work on detailing the hands and feet. We will learn how to construct a hand and a foot, their respective proportions and structure, and how to detail them. Also, to help you avoid creating common mistakes, I will show some key angles of the rest of the model.

The important thing at this stage is to finish the structure of the model as whole and to make all the elements work together so that in the final part, we can add the final details, expression, and hair.

01: Palm construction

Since we have the whole model blocked out, we can now start work on the hands. The first step in modeling the hand is the construction of the palm. The palm is composed of the bones of the wrist and the five metacarpals (one for each finger). For blocking purposes, you can assume that the palm is more or less like a square, though if you want the hand to be very feminine, you can make it a bit longer.

It's also important to note that the fingers are attached to the palm in a curved line around the palm, not a straight one.

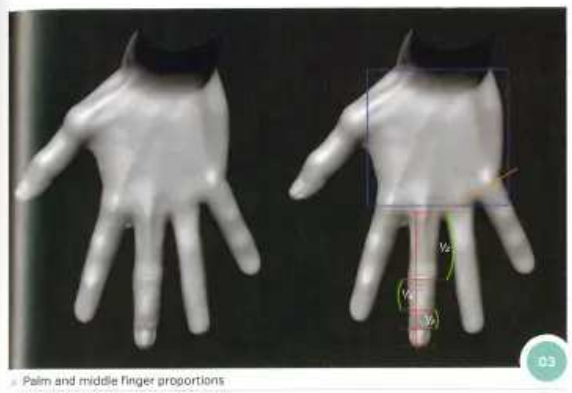
02: Middle finger construction

The next step is to block the middle finger. I do this now because the middle finger can be used as a guide for the other fingers. Also, it's the only finger that you can easily relate its size with the palm. The length of the middle finger is the same as the length of the palm; if you want a longer palm for a feminine hand, you will also have a longer middle finger too – that way the hand is always proportional.

After you set the length of the middle finger, you can place the knuckles and nail. It's important to note that looking at the nail from the front view, it appears quite curved, not flat! I will make the transitions deeper at a later stage, but for blocking purposes I like it to leave it like this, as shown in fig.02.

▲ Top view of the palm and fingers

▲ The middle finger showing the knuckles and nail



▲ Palm and middle finger proportions

03: Hand proportions

Fig.03 will help you to understand the proportions of the hand. You can see that the palm fits nicely into the blue square. Notice that the orange line cuts across the corner of that square, making the base of the fingers rest on a curvy line, rather than a straight one.

You can see that the middle finger really is the same length as the palm. To add the knuckles and nails, divide the finger in half to get the first knuckle, in half again to get the second knuckle, and in half again to get the start of the nail. With those measurements, it's very easy to build a hand.

▲ Pay attention to the size of each finger

04: Blocking the rest of the hand

Now that we have defined the palm and middle finger, we are able to block the entire hand. Follow the same rules to build the knuckles and nails for all the other fingers. The trick is knowing where each finger ends – for that we use the middle finger as reference (that's why we started from it). The index finger and ring finger may differ in size, but a good rough guideline is to keep them in line with the start of the fingernail of the middle finger.

The pinky ends at the last knuckle of the ring finger and the thumb ends at the halfway point of the first phalanx of the index finger – remember that the thumb itself has only two phalanx, instead of three. After you define the length of each finger, you just apply the same rule of half to each one, then you've got your hand sorted out.

▲ Remember that fingers aren't completely straight

05: Views of the hand

Make sure you look at the hands from different angles when modeling so that you get the curvature of the fingernails that I mentioned earlier. You'll also notice that each finger is not perfectly straight; all of them curve slightly towards the middle finger. If you draw an imaginary line continuing that curve, all four fingers' curves would converge. That is a detail that a lot of people often forget and I think it's very important to keep it in mind;

making the fingers perfectly straight would make the hand look very plastic.

06: Arm modeling

Now it's time to add a little more detail to the arm. It's important to notice the placement and angle of the biceps here, and how the muscle comes from underneath the deltoid. Also note the two bony landmarks (epicondyles) of the elbow and the twist of the forearm; see how the elbow and wrist look in this position. These areas should always be the reference as it makes it much easier to place the flexors and extensors on the forearm.

Also, notice that even this is not yet the final form; you don't see many strong lines between the muscles – the transitions here are very subtle.

07: Knee and thigh modeling

Now that the hands and arms are done we can move on to the legs. The knees are the first thing to look at because they are very distinctive. The patella works as protection for the knee joint, so when the leg is flexed the patella slides to the middle of the joint, protecting the ligaments.

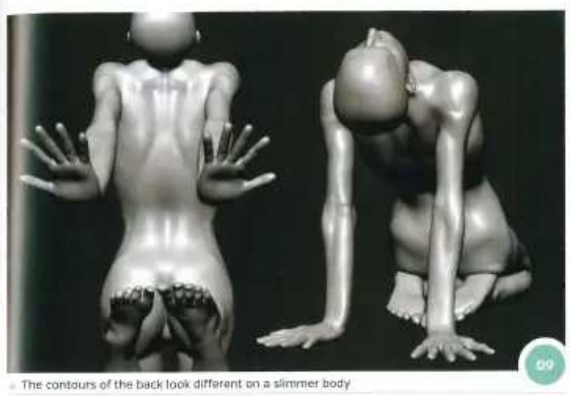
You'll also notice that the femur epicondyles on the sides have a bit of a sharp edge. This is due to the slim form and pose of the model – you'll find these areas are much more noticeable.

08: Front of the thigh

As the model has very little body fat you can see that the muscular mass plays a small part in the volume of the thigh. What you actually see most of is the volume of the bones. You can see the curve of the femur very clearly, and a very shallow surface where the thigh muscles

▲ Note the visible contours on the arms

▲ The angles are quite sharp here because the model lacks body fat



▲ The contours of the back look different on a slimmer body

▲ Here I have revised the head size to be proportional to the rest of the body

latae on the side of the hip bone. Usually on a woman, this part would be covered in fat, especially on the side.

09: Back and shoulders

If we look at the model from behind or underneath, we can see the compression of the two scapulas, but since she is very thin, you don't see a bulge of flesh between them – you just see a depression which indicates a hint of the spine. It's also possible to see: the insertion point of the trapezium on the clavicles and scapula, the flatness of the acromion process, and the start of the deltoid.

On a model in this pose with more body fat, the spinal erectors would not be very evident, but since this model doesn't have any fat they are very noticeable. It is also possible to see the posterior superior iliac spine due to the lack of fat.

10: Side view of the model

When I started working on the feet, I gauged the size of the feet in relation to the shin (more or less half of it), but on reflection the feet seemed huge compared to the head; after analyzing the model, I notice that the head is much smaller than it should be.

This usually happens when you block the model, so to refine it you just work with the part isolated. As you can see in fig.10, the changed head size works better with the torso and the feet, and the feet have a good relation with the leg size.

11: Refining the head

Sometimes you may find that you have completely ignored something vital, which can mean that your model looks wrong – such as the small head in the previous step. If we at look the model now, the size of the head looks much

would normally be. You almost can't identify the quadriceps (on the outside of the thighs) or the adductors (on the inside), and the depression that's usually formed by the sartorius is nonexistent.

From the side, you can see the origin of the rectus femoris on the illiac and the gluteus medius and tensor fascia

▲ This slim model has very little fat and reduced muscle mass on the thighs

▲ Take time to assess your model from multiple angles

better; note that I scaled it up by at least 20%, and that is a huge difference.

It is very important not to spend hours at a time when modeling. Remember to take a break (of at least 15 minutes) every now and then. This is not only good for your general health but also taking a break can help you notice any

▲ Don't forget that the clavicles are curved!

▲ Make sure you get the neck muscles correct

inconsistencies. If I hadn't stopped modeling, I could have very easily missed a big mistake like a small head!

12: Clavicle

One more important point I'd like to make before moving onto the rest of the body is the importance of checking the volume of the clavicle. One of the most common mistakes made by artists is making the clavicle straight, when in fact it should be curved.

I imagine that this happens because it can be very difficult to find a reference which shows the clavicle from a good angle. If you change the view of the sculpt in order to be able to see it from a new angle, such as in fig.12, you can observe the curved edge. The clavicle follows the curvature of the rib cage, and that's very important.

13: Neck muscles

Here is another example of structure that is often wrongly sculpted. The sternocleidomastoid muscle originates on the mastoid process behind the ear, then splits into two heads, one inserting into the clavicle and the other one into the sternum. It's very common to see artists insert both into the clavicle.

Also note that one head goes into the sternum, which can help to make a model look more realistic. This is more obvious when a person is standing up and looking to the side. Note that women don't have an Adam's apple, however, the tubular shape of the throat is quite prominent in this pose and angle.

▲ Make sure the foot is planted on the ground properly

▲ Starting to model the toes

14: Modeling the feet

The first thing that I like to do when modeling the feet is to ensure that the footprint is properly planted on the ground. You can imagine the plant of the feet as a rectangle, with its width around a third of its length.

On the outer side, it's possible to notice the protuberance of the pinky metatarsal. On the inner side you have the convex curve of the arch of the feet. Notice that, like the hand, the toes don't start on a straight line.

15: Toe modeling

After I've got the plant of the feet working, I start work on the first toe. The nail follows the same pattern of the hand with very subtle differences. The toe has only one knuckle, which is usually placed higher than the plant of the foot; you'll notice this position on the side view.

The tip of the toe is very round and has a cushion-like shape - it's very round on the sides and flat on the bottom. It's important to leave the space between the cushion and the sole of the feet; you can make them closer but always keep in mind the higher starting point of the toe.

16: The other toes

Now I repeat the same process for the other toes. This is essentially the same procedure, though you should keep in mind some key rules here:

- there are variations between the sizes of the first (big) toe and the second toe; on some models the first toe will be longer, on others the second toe will be longer;
- the three middle toes are tightly packed together and always point towards the same direction, away from the body;
- the cushion of the big toe usually has a snake-head shape, which is wider at the base and thinner towards the tip. The smallest toe points towards the body and tucks underneath the fourth toe.

To figure out the curvature of the toe origins (this varies a lot: those of Asian origin for instance have very straight toes), imagine that the small toe ends on the same line that the big toe starts.

17: The full model

In fig.17 you can see a print of the model at this point in the process. There are some interesting things to notice at this angle, such as the asymmetry of the feet and the tension on the elbows. The level of detailing on the body here means that you can see everything, but nothing is too strong, which makes the model light and natural.

▲ Toe placement and orientation

▲ The full model

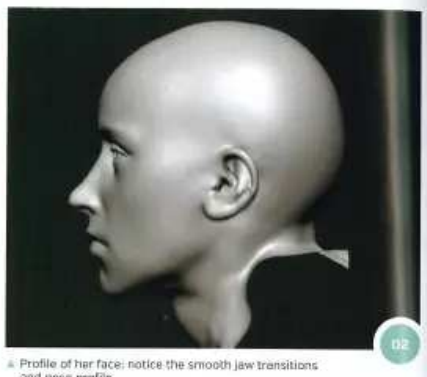
Slim female

Part 03 | Final details

By César Zambelli

Digital sculptor

▲ Making her head rounder and less gaunt improves the overall look



▲ Profile of her face: notice the smooth jaw transitions and nose profile

In the last part of this three part chapter, we will work on the final details of our underweight figure to make it look realistic. We will look in detail at small surface details, subtle details on her face and hair, as well as other tweaks to add that extra touch of realism. We will also check if the proportions need correction. These last steps are crucial as this is what defines whether the model is going to be great or just good.

The differences between the figure at

01: Head improvements

I am not happy with my model's face; it's too gaunt and doesn't look right, so I make the overall shape of the face rounder.

I also make various tweaks to the overall form. I work on the eyebrow region, make the eyeball pop out a little, and make a better mouth, with thicker lips but a narrower shape. The depressions on her cheeks are also smoothed, making her look younger.

that is what I find attractive. Also, the chin is very discreet and the jaw corner near the ear is very round and subtle.

A common mistake I often see is when an artist gives a female jaw a sharp corner and makes a big depression between the corner and the sternocleidomastoid muscle. Keep in mind that even on a skinny figure like the one that we are using, the transition is very subtle.

03: Whole body - side view

This is an overall analysis of her model at

but using the same mesh is vital to work the transition between forehead and hair in a more traditionally sculpted way. At this stage, her body is ready and the only things that we need to do now (besides the hair) are small details.

04: Hair - base mesh construction

Now we have to add the additional mesh for the hair model. If it's a short hairstyle, we would not need that and just using our base mesh would work. Since she has a long hairstyle though, we have to add more polygons to that region to work. You can do this in two ways. One method is to merge the previous hair SubTool and DynaMesh the whole model, then use ZRemesher. Another way is to import the base mesh into another package and extrude the hair mesh manually.

I generally follow the second option, because when you DynaMesh it, the whole model merges, and parts like the thighs and calves, heels and buttocks would merge into one single piece, and that's bad. So I extrude the mesh, import it into ZBrush, and start to project all my details onto the new model. This is way easier than it seems and means that we keep our base mesh with all the polygroups.

05: Hair - first blocking

Now that we have our base mesh, we can start to develop our hair. Hair is very tricky to do because you have to interpret it instead of just copying it.

You have to imagine the hair as one mass and interpret where you need dark values and brighter ones. If you want your hair to look darker, we can create more depressions and differences in volume; if it's blonde hair, for instance, you have to dial that down and make a more even

▲ An overall look at the model before adding the mesh for hair

▲ The best way to approach the hair base mesh creation

the end of the second part and the final one here seem small at first glance, but if you look carefully you will see how much it improves. Even though the differences seem less significant, it often takes a lot more time to finish the final touches than it does to complete the previous two stages.

02: Head improvements

It is always good practice to look at your model from different angles. The profile view is just as important as the frontal view because it gives you a better look at the nose and chin. I have given the model a very delicate and feminine nose, with a slight point, mainly because this is an overall analysis of her model at this stage prior to adding the hair mesh. When you are working on something that you want to look like a real sculpture, try to make the hair and the head with the same mesh. Using two SubTools will look too separated and will not work. Of course you can use the two SubTools technique if it's a ponytail, for example, hair, so that you get a brighter hair effect.

Hair modeling has to be divided in stages – you can't just start with thin lines and you must first work on the volume as a whole. We can see in fig.05 that there isn't any detail, but the hair movement is already there.

05

First look at our hair blocking

06: Hair – detailing

Now that we have our hair blocked in, we can start to add the details. Keep in mind that when you are adding the details, you have to do it while thinking of the hair as layers. For each layer of detail you use a smaller brush, until you get to the thinnest ones for the last details.

I choose to make hair that doesn't look as dark as the reference. It is very important to avoid parallel lines – this is crucial in achieving a natural look. Hair takes a lot of time to do. It will not look good if you do it fast so you have to take your time.

One last trick: with a thin brush, add some hairs going in different directions to the clump that they grow in, making the overall hair look more natural.

07: Final improvements – face

Since we are working with the hair, now is a good time to add the final touches to her face. I add the iris and pupil (some people like to add a little sphere to simulate the specular highlight, but I'm not a big fan of that). Also on the eye, you'll notice a hint of an eye lash on the upper eyelid; I think this creates a good effect.

I also work at her nose: we can see the volumes of her cartilage and the inside of her nostril is tweaked too.

When I model a female figure, I like to make her mouth slightly open, making her looking more alive. I add some eyebrows, bringing back a little bit of the squareness of her face so that it's more in keeping with her slim body.

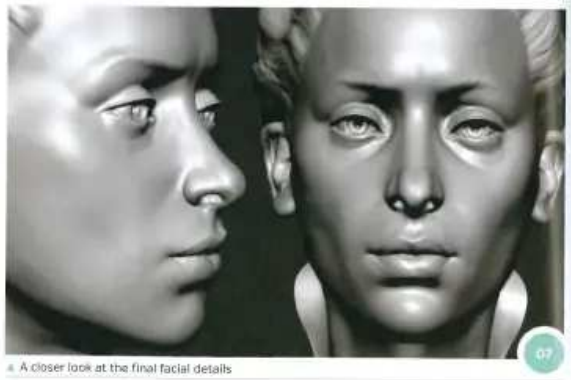
08: Final improvements – torso

Now, going down a bit further, I add the last details to her upper torso. I add a bit of definition to her nipples, work the humerus head a bit more, and add more definition to her ribs.

This is something that I wouldn't normally do, but looking at her photos, I really feel the need to sharpen the ribs edges a bit more than usual. But

06

Hair detailing process



07

A closer look at the final facial details

08

Final tweaks to her upper torso

09

Top view of the upper torso, showing some interesting transitions and shapes

10

Belly button close up, showing its shapes

11

The back – final look

even if the model is very skinny, you should always carry out this type of adjustment very carefully; if you sharpen a bit more than you should, the figure will appear very unnatural and stiff.

09: Final improvements – top-down view of torso

Now we look at the torso from another angle. At this angle you will notice the "S" shape of the clavicle, the relationship of the clavicle and the humerus head, and the position of the trapezium. It's also very important to notice the roundness of the rib cage, which gives the torso its shape.

Another interesting aspect to look at from this angle is the abdomen attaching on to the sternum. Since she is very skinny, you can see the transition from that part of the sternum with the abdomen muscle and the rib on the side with a sharper edge.

10: Final improvements – navel

One thing that is often neglected is the navel or belly button. You have to understand that the belly button isn't just a depression in the middle of the abdomen. It has a particular shape. First, one thing that you can notice between man and woman is that a man's belly button tends to be more horizontal, and a woman's more vertical. Also, the hole isn't just a hole; if you look closer, you'll see that the sides of the hole meet inside. When a person doesn't have much fat you can see a depression just over the belly button. Adding this makes the lip of the navel a bit higher and makes it look more natural.

11: Final improvements – back

The back of this model is something that doesn't appear a lot in the chosen pose, nonetheless it's very important that we work on it, otherwise the model could look very odd at some angles. I add a few details to it, make the trapezius look a bit bigger, fix some scapula angles, and work on her spine.

Note that near her neck the spine is more prominent; as it goes lower and

gets compressed between her muscles, instead of looking at a bump all we see is a depression. Something that can add to a sculpt are little vertebrae details on her lumbar region; when you add details like this though, for example as with the hair, avoid parallels and even distances so that the model looks natural.

12: Final improvements – legs

In fig.12 you can see the final details on her left leg. I make her knees a bit more angled on the profile. You can also see the femur condyles and how the patella slides down to protect the joint. I smooth the iliac a bit, as I think that it makes her look more natural. I work a bit on the side of the leg and the transition of the vastus lateralis, and a bit more on the calf volume and compression between the calf and thigh.

13: Feet – blocking

I work a bit more on her feet and work the proportion. If you look back at fig.03, you will notice that the shin is a bit long, making the feet goes out from underneath her more than they should. To fix that, I make the feet a bit shorter and smaller, and the shin shorter (I also make the feet smaller because the feet are proportional to the shin, and it was the shin that was not correct compared to the body). I also, make the toes' pose a bit more natural.

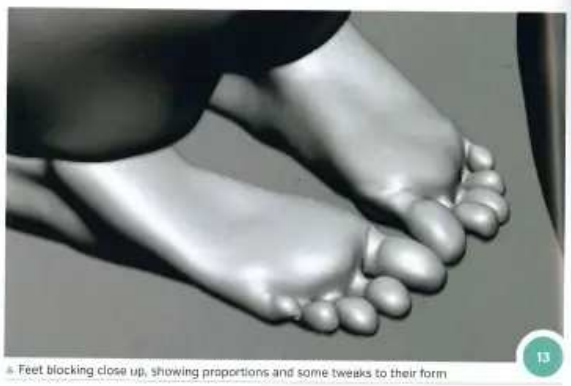
14: Feet – detailing

One thing that I think is really missing on this piece is the compression wrinkles on her foot. I'm not a big fan of doing all kinds of wrinkles; I tend to keep the sculpt showing wrinkles up to a certain size, but when it gets smaller than that, I often don't do them.

A lot of wrinkles don't look very good for

12

Final improvements to the legs



13

Feet blocking close up, showing proportions and some tweaks to their form

14

Final improvements to the feet

15

The overall look of her arms at this stage

look weightless. I keep the wrinkles turned down though – I just make their main volumes, not every depression.

15: Arms – detailing

The arms are almost complete already, the only thing that I do now is add the volume of the supinator, which was a bit faded previously. What I find interesting to look at in this image is the forearm and arm silhouette. Our bones play a major role in our overall silhouette, which is even more pronounced when the person is skinny. If you look closely, you can clearly see

16

Wrist structure and the alignment of the forearm bones and hand

this kind of modeling, to look more like a statue [if we were doing a model for skin shader and subsurface scattering, I would do the wrinkles]. For example wrinkles on the finger joints are just something that I don't do; I just do their volume. However, the wrinkles of the feet occur because of the feet being compressed, so if I don't do them, the figure will

▲ Close-up of the feet detailing, showing their wrinkles

if you look closely, you can clearly see the bones of the forearm near her wrist.

In order to get the forearm correct, you must understand that the two bones are not straight, but if you make them too curvy, the forearm will look broken. When it comes to forearms, use as much reference as you can because they are very complex.

16: Wrist structure

It's common for modelers to say that knees are hard to do but, in my opinion, one of the most underestimated parts of the body are the wrists. You must understand where the forearm bones end and when the metacarpals start. In between those two are the eight carpal bones and its volume changes a lot when you change the position of your hand. In this case, we can see a slope that the carpal bones create. If we just do a straight connection between the forearm and hand, the figure will look awful.

17: Final touches to the hand

As I said before, I don't like to do the wrinkles in some areas. You will notice

how the hand is subtle, you can just see a hint of the excess skin over each finger knot. Since her fingers are slightly tense, the tendons on the top of the palm appear. Be careful not to overdo these because if you do her hand will look much older.

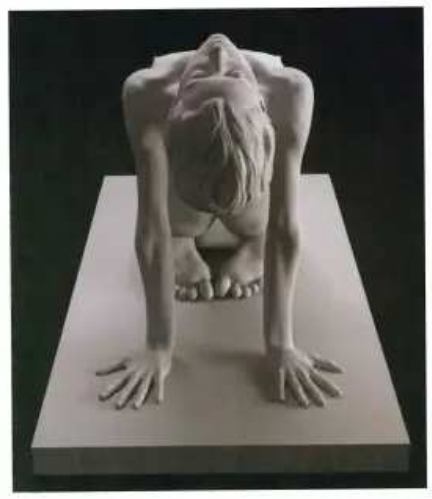
You will also notice how the nails are subtle and round. When creating nails you have to understand their different planes – looking from the front view, they are very round, not flat. As always, the transitions are very subtle.

18: Final render

Now we have a final figure, this is the perfect time to make any adjustments or changes to your sculpt. You could add a different texture to her skin or maybe a few imperfections for that extra touch of realism. You can see various angles of the final render on the next page.

▲ Hand detailing, showing how subtle and delicate a hand should look

▲ The final render



Advanced topology

For the advanced modeler or artist working in an animation pipeline, retopology is essential for making the best

Advanced topology

Retopologizing

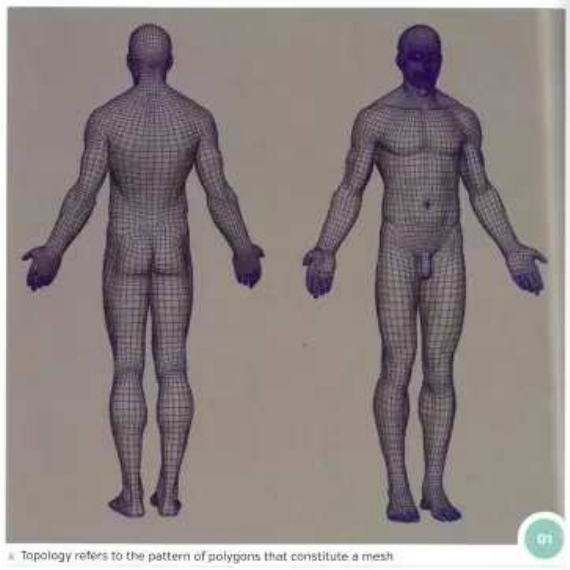
By Daniel Peteuil

Character artist

Understanding anatomy is essential for all figurative artists. However, as a 3D figurative artist, if you want to create figure models for an animated medium (films, games, and so on), you must also have an understanding of the technical requirements necessary to make that figure work well during animation.

The topology of your figure's polygon mesh is at the core of this. The ability of your figure's topology to deform and define well during animation is what determines its quality. You want your model to look realistic in the static pose it was modeled in; good topology is the way to ensure it still looks realistic when it's moving.

Your figure will always be moving during animation, so good topology is a way to ensure that all the work you did on your static model transfers well during motion. For this reason, it is an essential skill we all must learn. If you want to create great figure models for animated mediums, you need to be able to understand and create great topology.



▲ Topology refers to the pattern of polygons that constitute a mesh

01: What is topology?

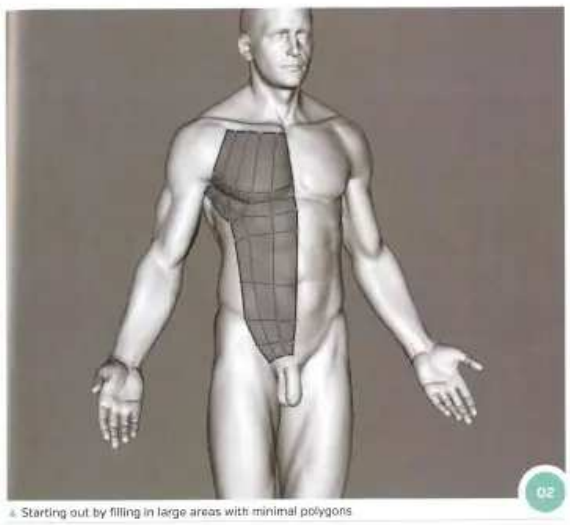
If you are unfamiliar with it, topology is the term that is used for the pattern of polygons that make up a 3D mesh. Good topology consists of clean edge flow that will describe both form and movement.

It is important to note that good topology will always depend on the needs of that specific character or asset. What defines those needs will vary according to what it is going to be used in, for example films or games, and also what type of form, gender, or even species, the character will be.

The edge flow of our model needs to define the archetypal male anatomy and the manner in which that anatomy will move and behave during animation. In this tutorial I will break down the elements that define these attributes of topology.

I recommend that you create your mesh with some type of retopology software. There are many options and it's best to research and try them out to find the best for you. Please note that this tutorial won't discuss specific software as we're more intent on learning the basic topology principles.

With retopology software it is very easy and helpful to line up edge flow that will define specific important forms perfectly, which is much more intuitive than older modeling methods. At the core of retopology software is the ability to snap your new mesh over an existing high-poly reference mesh. Your reference mesh will be a model on which you have already sculpted and created the main forms that will be represented in your final model.



▲ Starting out by filling in large areas with minimal polygons

▲ Identifying areas of the body where changes of direction occur

02: Workflow

My personal workflow is to start my retopology by filling in large areas with minimal polygons and focusing on where the edge flow will change direction. The areas that require the most focus for change of edge flow direction on the body are joints and big forms. These are where the most extreme deformation will happen. The most noticeable areas of quality topology will be here as well, so keep that in mind when evaluating topology.

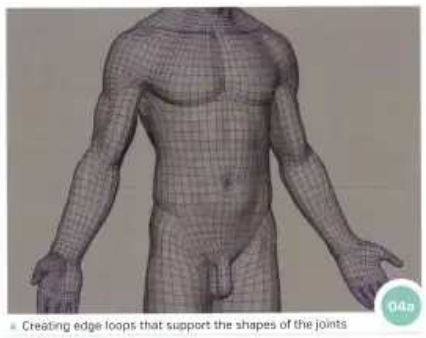
03: Changes of direction

A change of direction can be found at a vertex that connects more or less than four edges. These will always be found near the origin of an appendage or extrusion, for example where the neck meets the head.

The most noticeable changes in direction are typically at the shoulders and hips, as they are the largest areas of direction change. This is comparable to them being large areas of form change in the anatomy.

04: Elbows and knees

Elbows and knees are extensions of an existing form, but are still important for edge flow because they are often the joints with large movements and therefore more extreme deformation. For these areas it is helpful to change some edge loops to support how the form looks when deformed during animation (fig.04a). To be more specific, it is good to have edge loops that define the knee cap/elbow on one side, and edge loops that define the pit of the knee/elbow



▲ Creating edge loops that support the shapes of the joints

▲ A closer view of the edge loops at the inner elbow

▲ Edge loops on the knees that will help give a clean deformation

▲ Corresponding edge loops on the backs of the knees

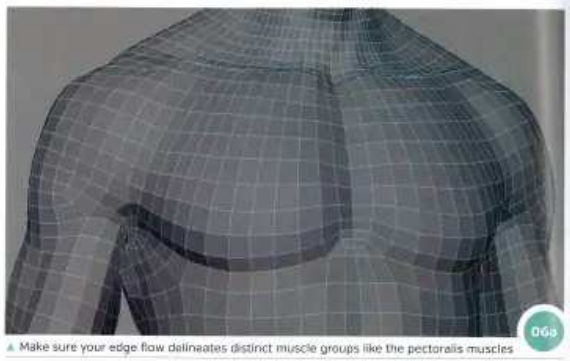
on the other (fig.04b). This will help them to keep their shape when bent.

05: Joints

Joints are also very important because they often have the most complex form, as they are where all the muscle and bone meet. This is also where most deformation during animation will occur. So for those you want to keep a smooth mesh, but also have edge loops that help define and keep those forms represented during deformation (fig.05a, fig.05b).

06: Large forms

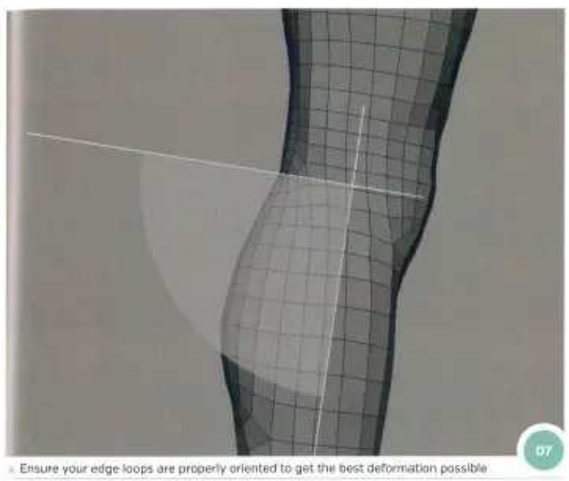
Large forms are also important. For example, you usually want an edge flow that defines the pectoralis muscle group and gluteal muscle group. These are big forms that tend to make a very distinct crease or fold when moving in animation (fig.06a, fig.06b).



▲ Make sure your edge flow delinaates distinct muscle groups like the pectoralis muscles

07: Edge flow orientation

It is important that your edge flow is oriented in the proper direction. This may seem simple enough, but I



▲ Ensure your edge loops are properly oriented to get the best deformation possible

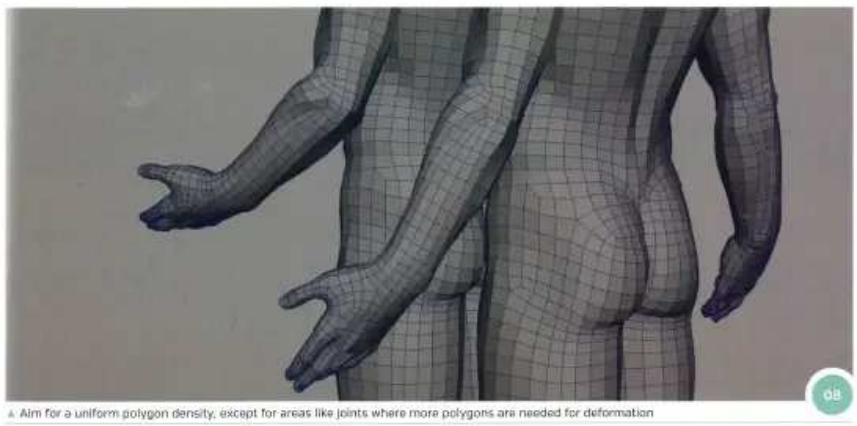
can be a special case where a higher density can aid in deformation; after all, the polygon density in these areas will change during deformation. It's important to keep that in mind – when an arm bends, you don't want the elbow to suddenly be lacking polygons and the shape to no longer be defined.

09: Complex areas

Areas like toes, fingers, and the face often need to have an increased mesh density because they have a much higher level of small and important forms. Mesh density is very much related to form complexity. More complex areas will generally become denser.

10: Clean topology

Something you will hear often is the importance of "clean topology", but what does that mean? "Clean" will generally

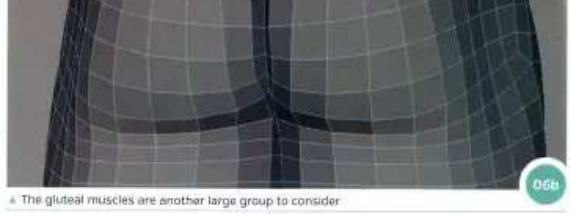


▲ Aim for a uniform polygon density, except for areas like joints where more polygons are needed for deformation

have seen professionals overlook this. Essentially, you want to make sure your edge loops are approximately perpendicular to the axis they will bend on to ensure a smooth bend and falloff.

08: Polygon density

It is also important to keep a fairly uniform polygon density. There are some exceptions to this, however. Again, joints



▲ The gluteal muscles are another large group to consider

▲ Intricate body parts may need a higher polygon density

▲ Watch out for wavy, crooked edge loops and correct them

refer to a mesh that is not overly complex and whose edge loops are straight and smooth. Be wary of wavy edge loops in your topology; how can your mesh deform smoothly if its static form is not smooth?

11: Quads versus triangles

Something you will also hear a lot is the importance of quads (four-sided polygons). The idea of strictly using only quads is very commonly taught in schools, though professionals tend to not be quite as strict with their use of triangles. For example, if you are working in games, you will be using triangles in your meshes.

Your mesh will triangulate at render time, and with limits on polygon count, using triangles is a great way to avoid arbitrary triangulation compromising your forms. However, keeping your mesh in quads is very helpful for editing and understanding edge loops and predicting how it will perform during deformation.

> "It is important to create edge loops that will support facial movements and line up with anatomy"

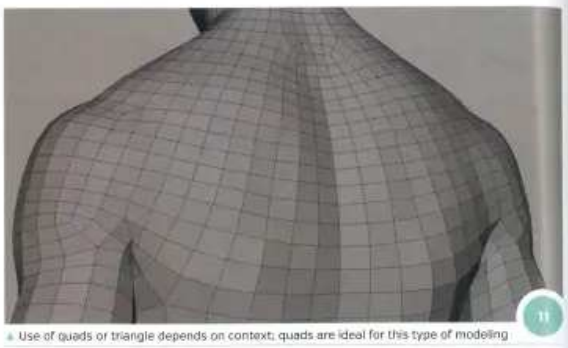
12: Importance of the face

Perhaps the most important part of any character is the face. This is where the personality comes from; it is what viewers connect with. It is not only where the most emotive and subtle animation/deformation will be taking place, but also where there will be the most scrutiny, since facial close-ups are common.

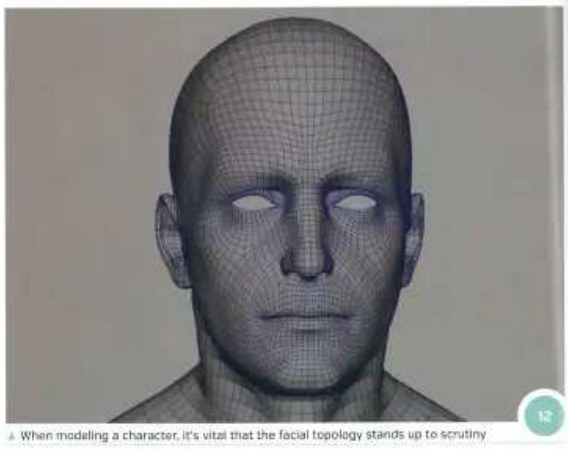
Therefore, it is not only one of the most vital parts for anatomy and sculpting, but also vital for clean topology that deforms well during facial expressions. For this reason, it is important to create edge loops that will support facial movements and line up with anatomy.

13: Facial topology: orbital muscles

Facial areas that need the most focus are the eyes, mouth, nasolabial fold, and brow. The eye and mouth are both similar in that the topology needs to allow them to open and close smoothly. It is typical

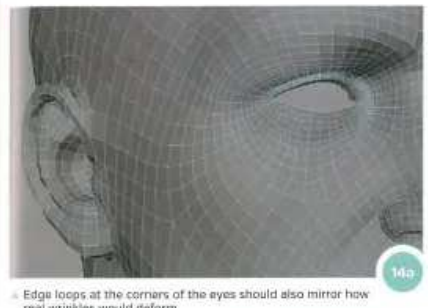


▲ Use of quads or triangle depends on context; quads are ideal for this type of modeling

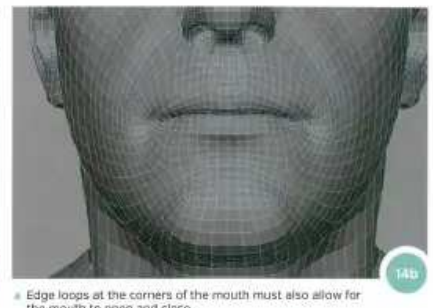


▲ When modeling a character, it's vital that the facial topology stands up to scrutiny

▲ Create edge loops that circle the eyes, mirroring real-life muscle structure



▲ Edge loops at the corners of the eyes should also mirror how real wrinkles would deform



▲ Edge loops at the corners of the mouth must also allow for the mouth to open and close

to create edge loops that circle around them, essentially matching the orbital muscle anatomy that is responsible for their deformation in real faces.

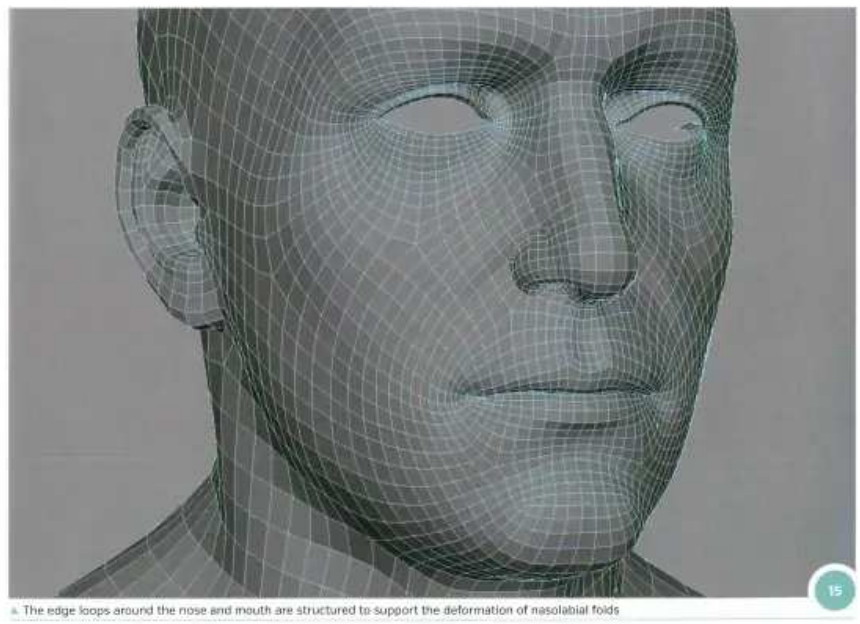
14: Facial topology: eyes and mouth

You will also want to be mindful of how your edge loops form at the corners of the eyes and mouth. You will want to make sure that they support the wrinkles that form there [fig.14a]. Also be mindful that the corners of the mouth will be stretching when the mouth opens wide [fig.14b].

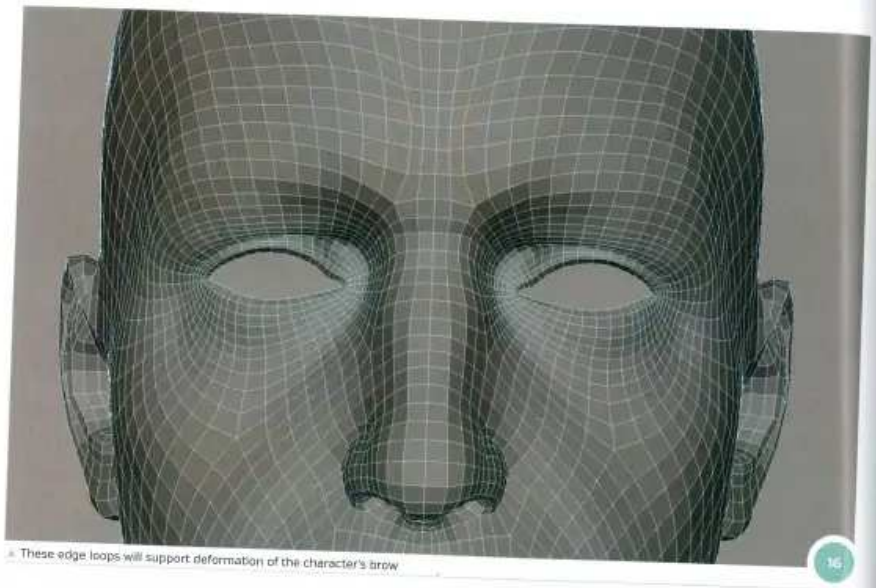
15: Facial topology: nasolabial folds

Other parts of the facial topology will need to support folds that form on the face. The most noticeable are the nasolabial folds that extend from the nostrils, around the corners of the mouth, and down into the chin area.

This is very important because the folds become exaggerated when a character smiles or opens their mouth, and the mesh should be able to cleanly represent that crease.



▲ The edge loops around the nose and mouth are structured to support the deformation of nasolabial folds



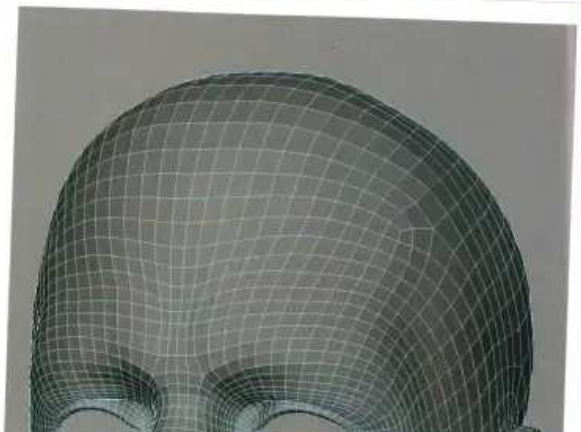
▲ These edge loops will support deformation of the character's brow

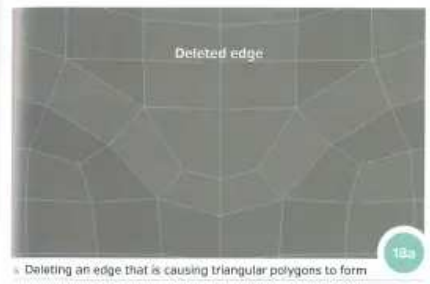
16: Facial topology: brow

Another area of folds that you will ideally align with your facial topology is the folds on the brow and forehead. When a character furrows his brow or makes an angry face, you will see creases form in the middle of the brow above the bridge of the nose. It is important to create edge loops that support folds for those facial expressions.

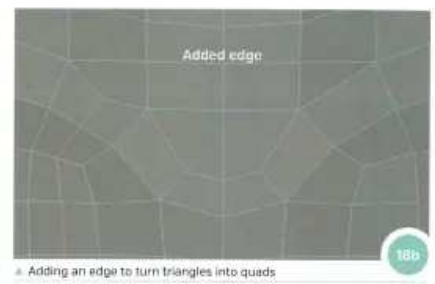
17: Facial topology: forehead

As for the forehead, the edge loops follow the wrinkles of the forehead (noticing a common theme yet?). While these aren't always noticeable on a neutral face, when a character raises his or her eyebrows you often get wrinkles that become prominent. It is important to have your





▲ Deleting an edge that is causing triangular polygons to form



▲ Adding an edge to turn triangles into quads

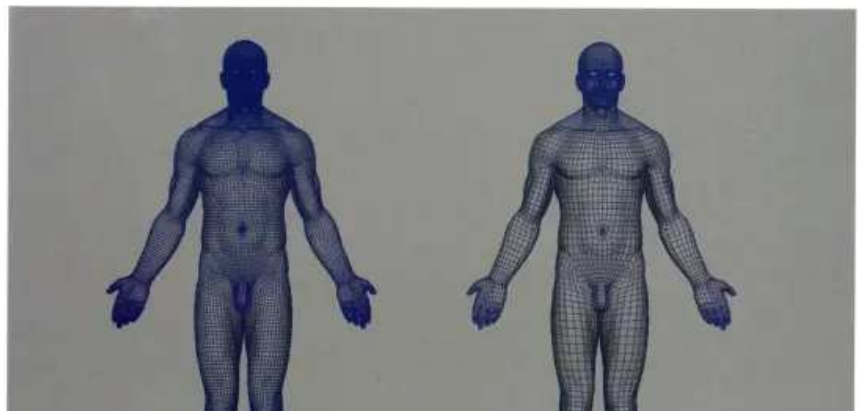
18: Refining

Often you will find yourself editing the mesh beyond your initial pass to try to make it more efficient and improve the edge flow. This can include tweaking edge flow direction and often will create triangles where you don't want them. To get rid of triangles you will generally have to delete [fig.18a] or create [fig.18b] an edge that will get rid of the third vertex on the triangle, or create a fourth that will make it a quad.

19: Finishing up

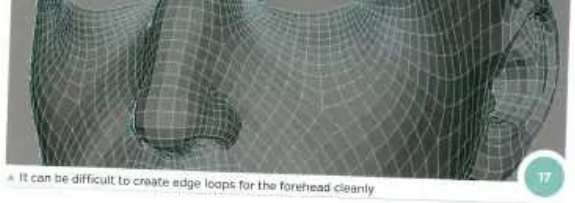
I often try to keep my base topology somewhat low to keep a clean and easily understandable mesh. If I want a higher resolution base mesh I can try to use the level 2 subdivision. I will then re-project it onto my high-resolution sculpt. After this I will continue sculpting and since the topology now fits the forms, it is often easier to sculpt cleanly. This is particularly helpful for the face around small forms like eyelids. It is still important to be mindful of which edge loops you are pushing around while sculpting.

Topology can be viewed in the same way as bones in anatomy: they are under the surface and not seen, but they keep the muscles together and make the final product look good. Now that you have a solid knowledge of what good topology is and how to understand it and create it, you can go out there and make your final product look great.



to better represent these wrinkles.

However, these folds vary from person to person in a way that may be hard to match exactly and keep a clean mesh. If that happens to be the case, just try to find a middle ground that you think will work well.

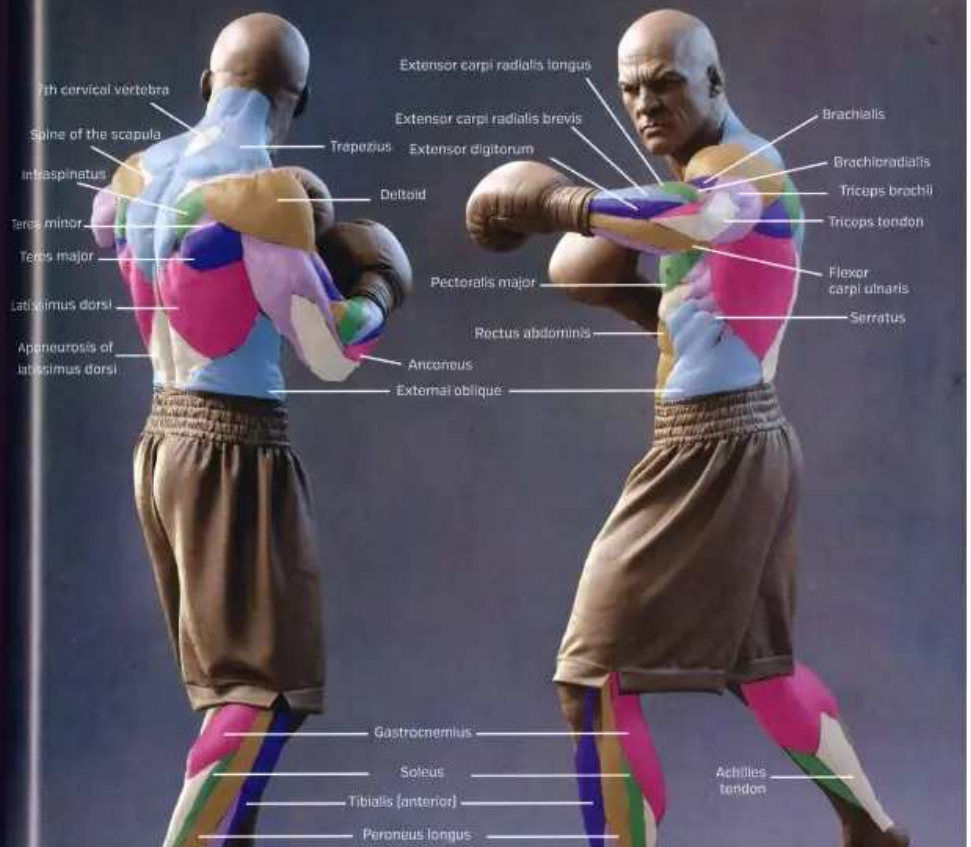


17 It can be difficult to create edge loops for the forehead cleanly

19 Topology may be one of the less visible aspects of modeling, but it's essential for getting a realistic, high-quality result

3D reference gallery

In this gallery, seven talented 3D artists showcase some beautifully sculpted examples of the human form. Some of the important muscle groups have been labeled so that you can see how they affect the overall shape and look of the final model. We hope that this collection of fantastic sculpts will inspire and inform you as you take the next steps on your creative journey.



Sandeep V.S
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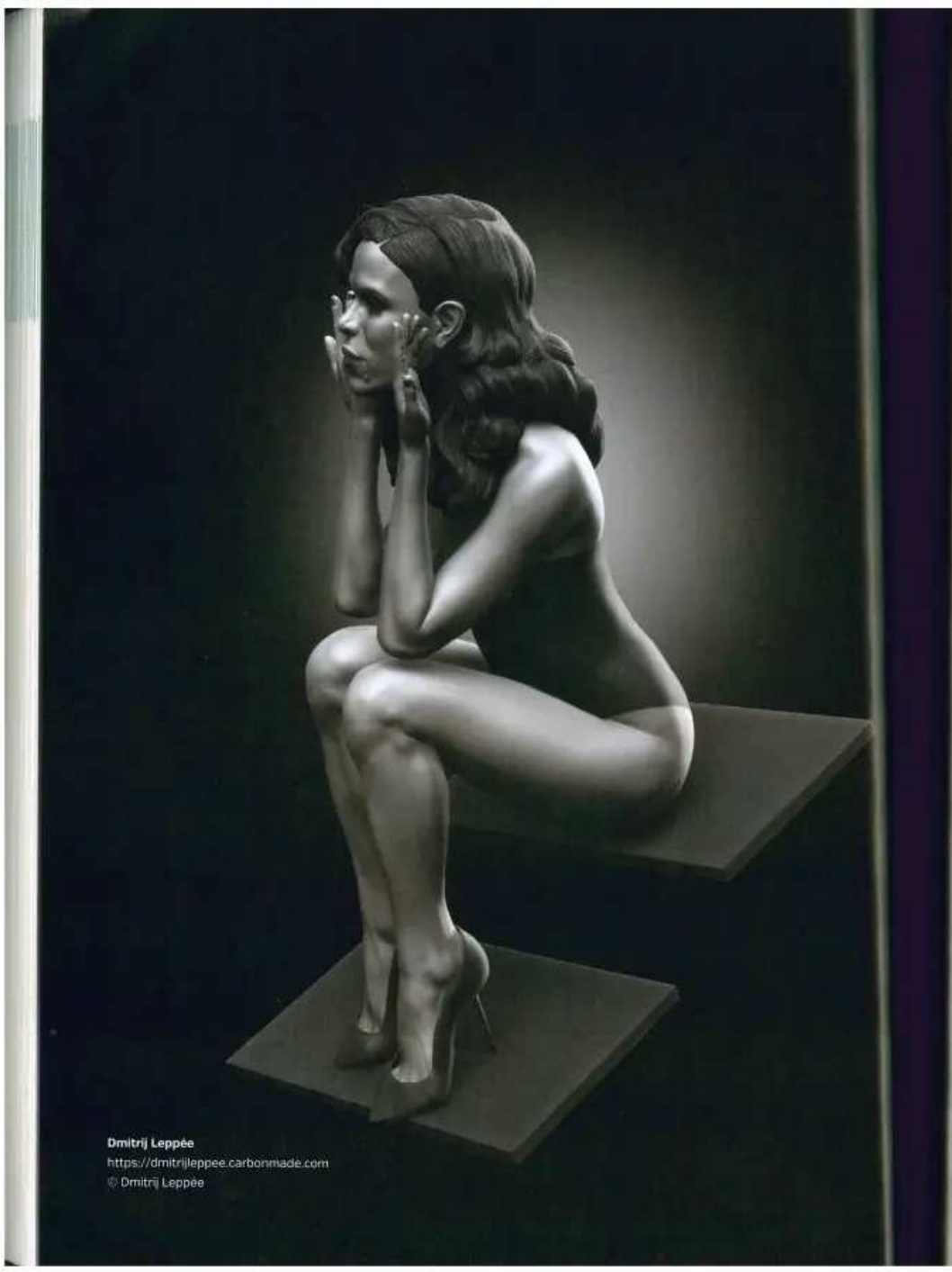

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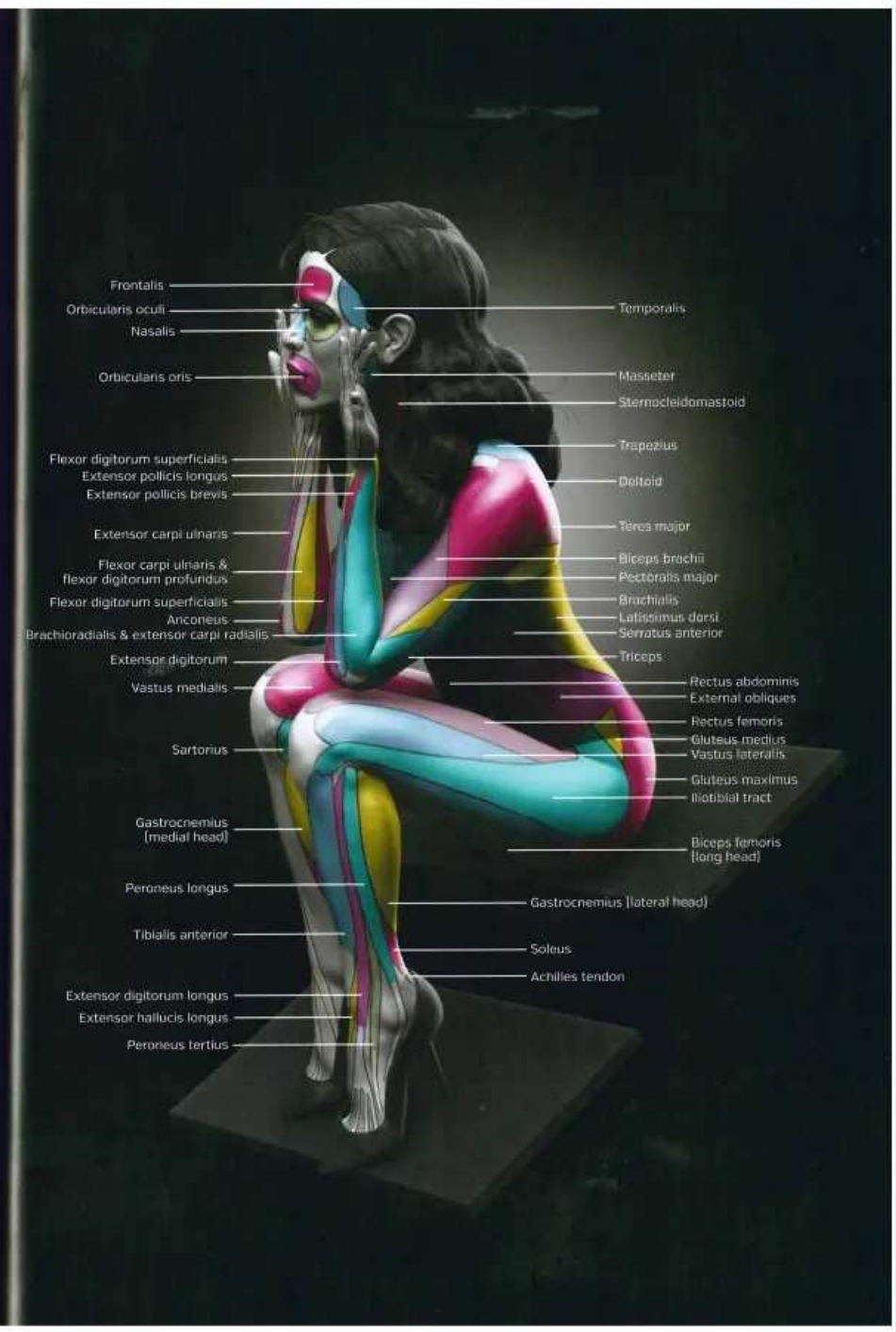

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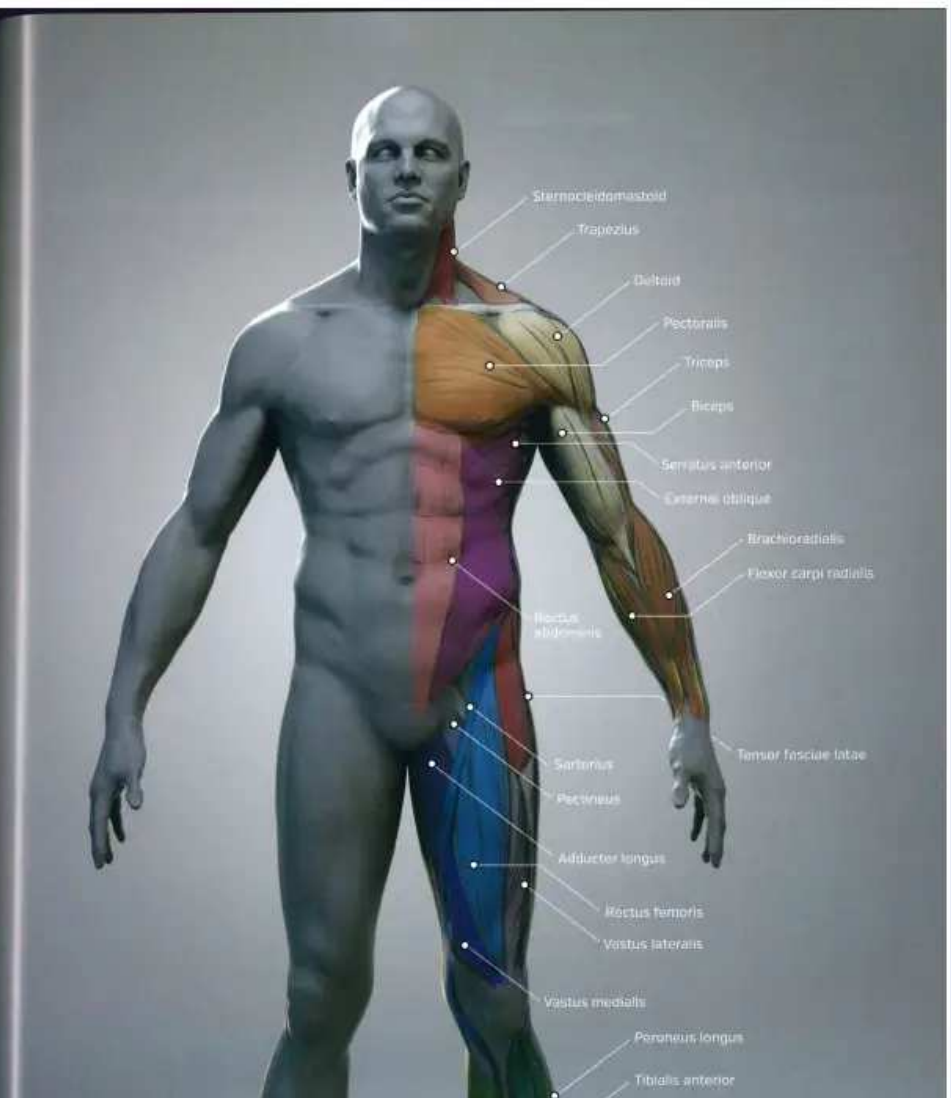

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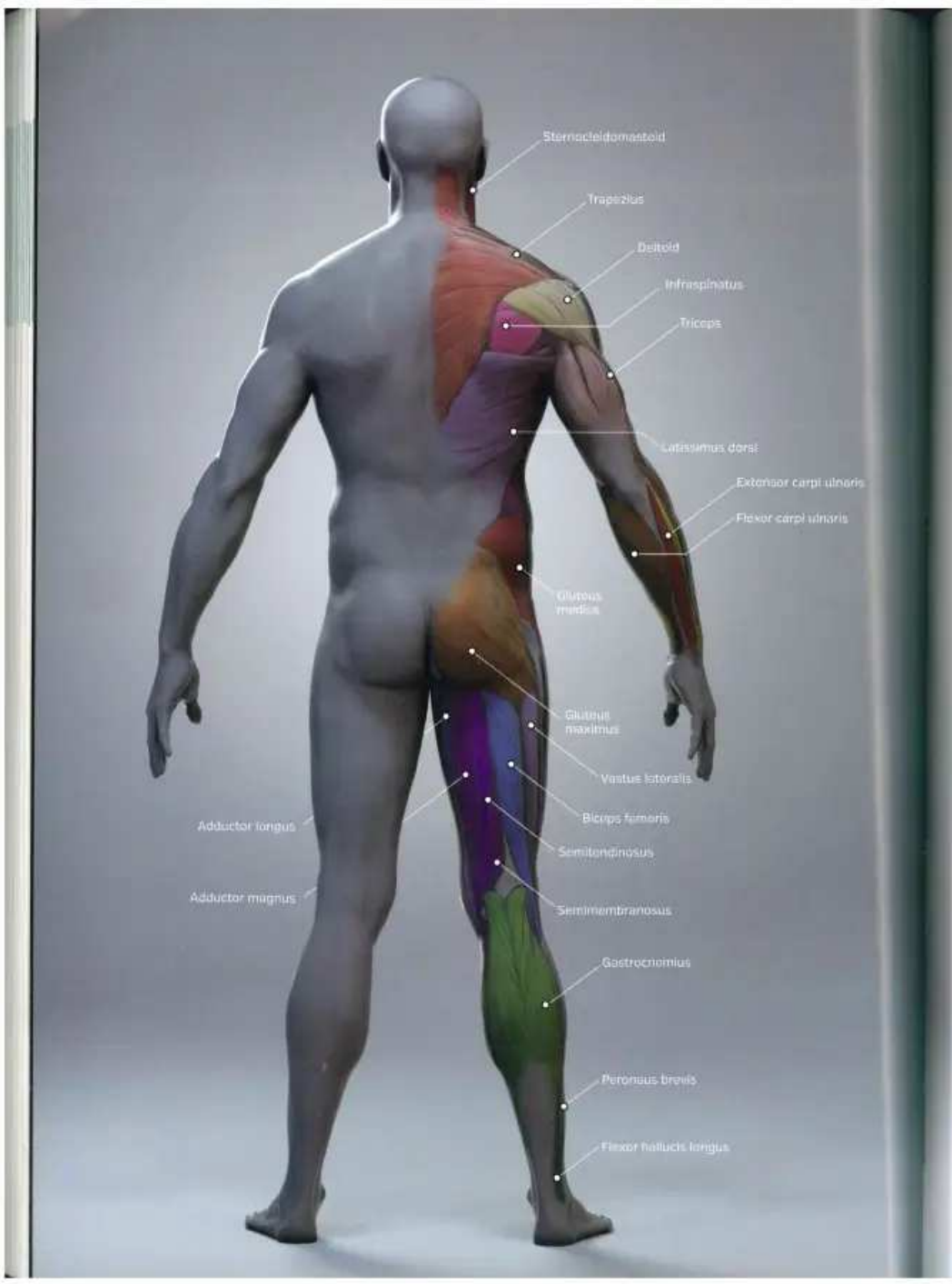
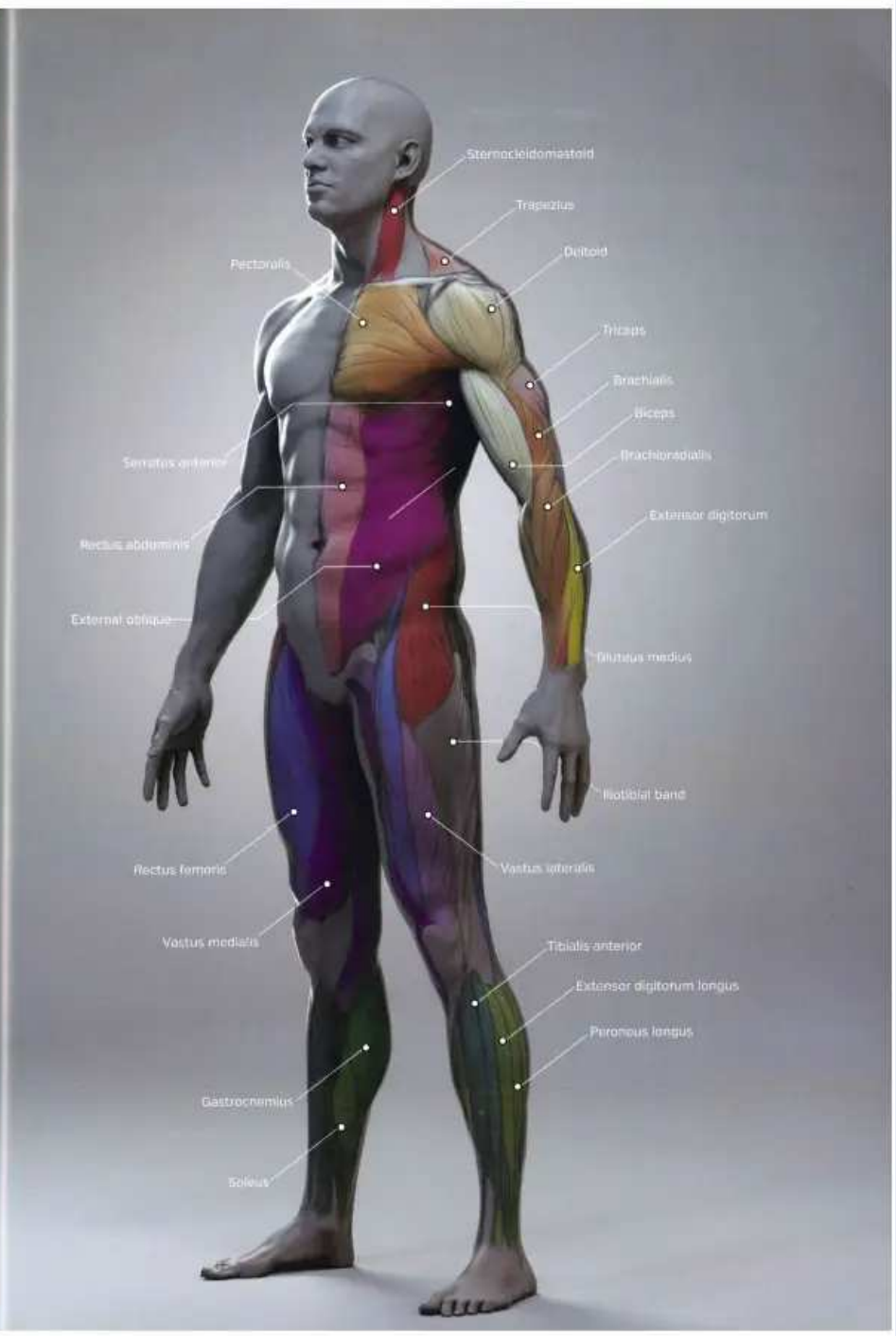
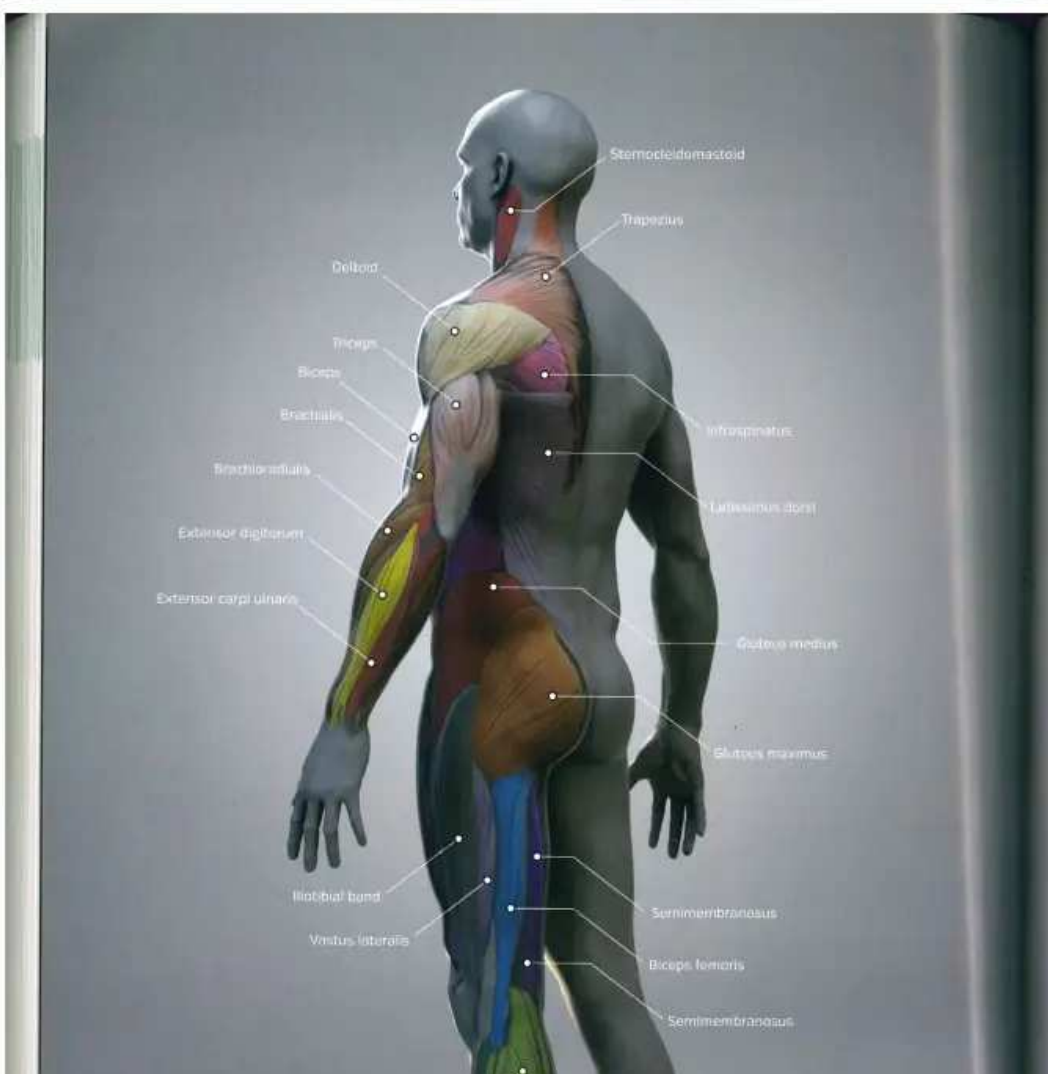
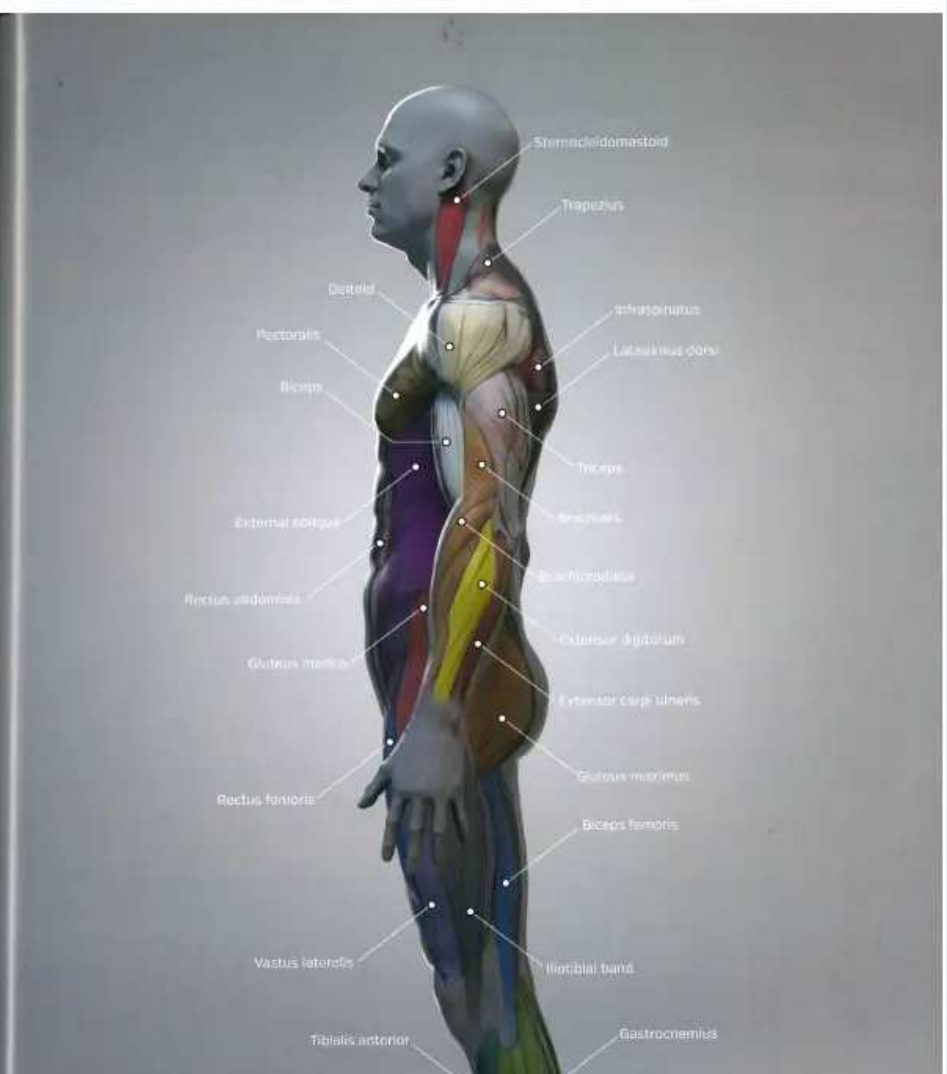
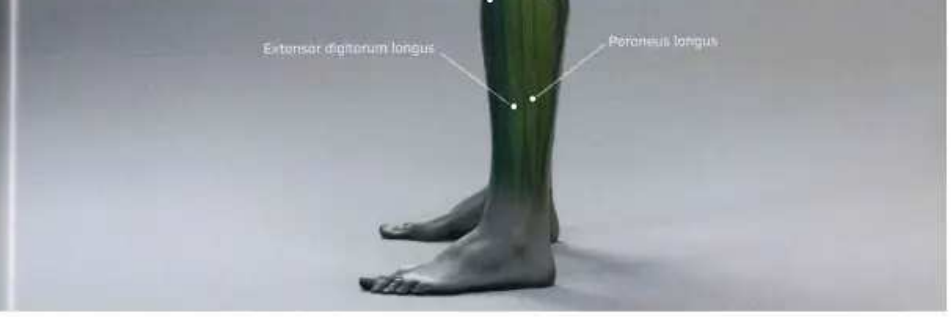


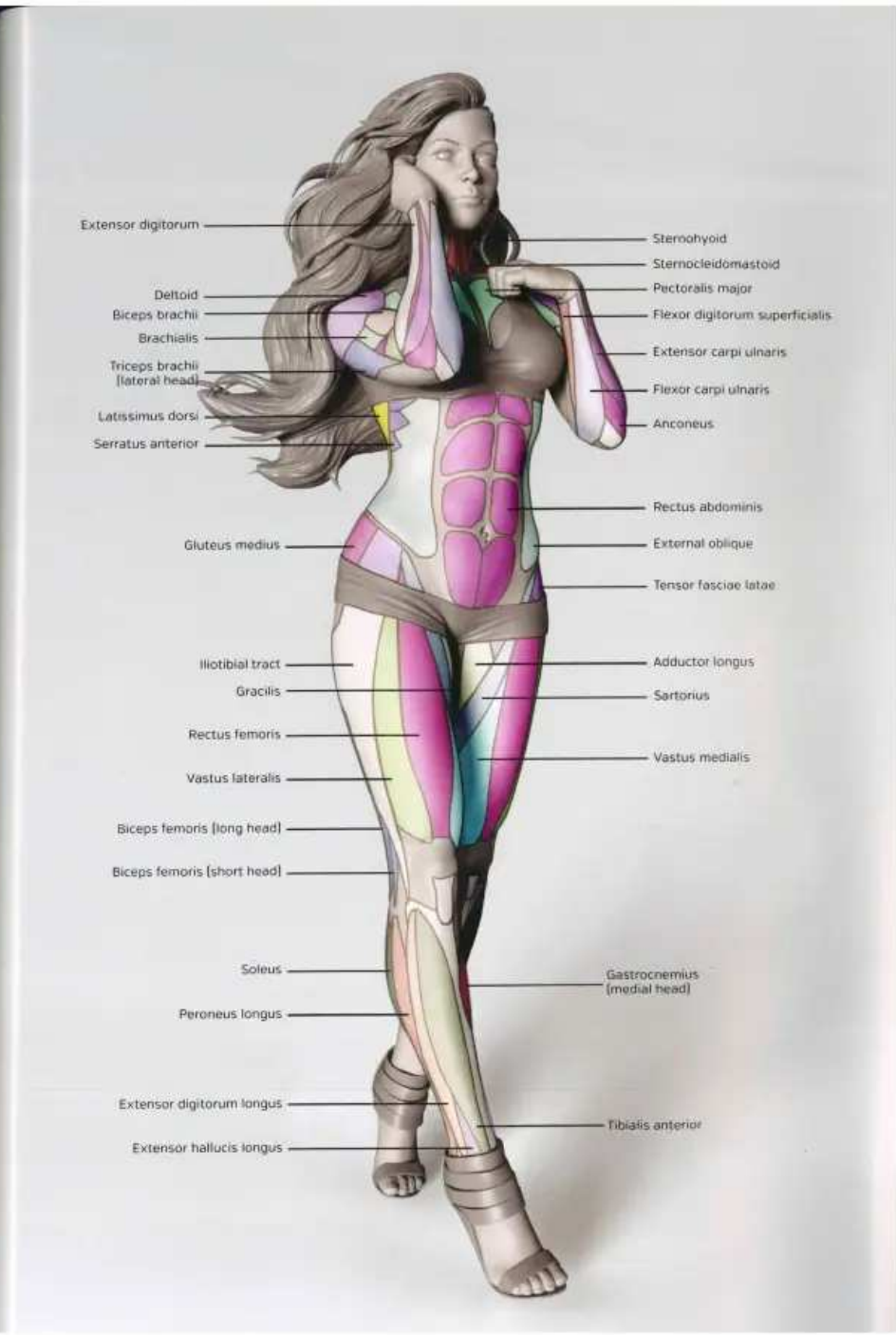


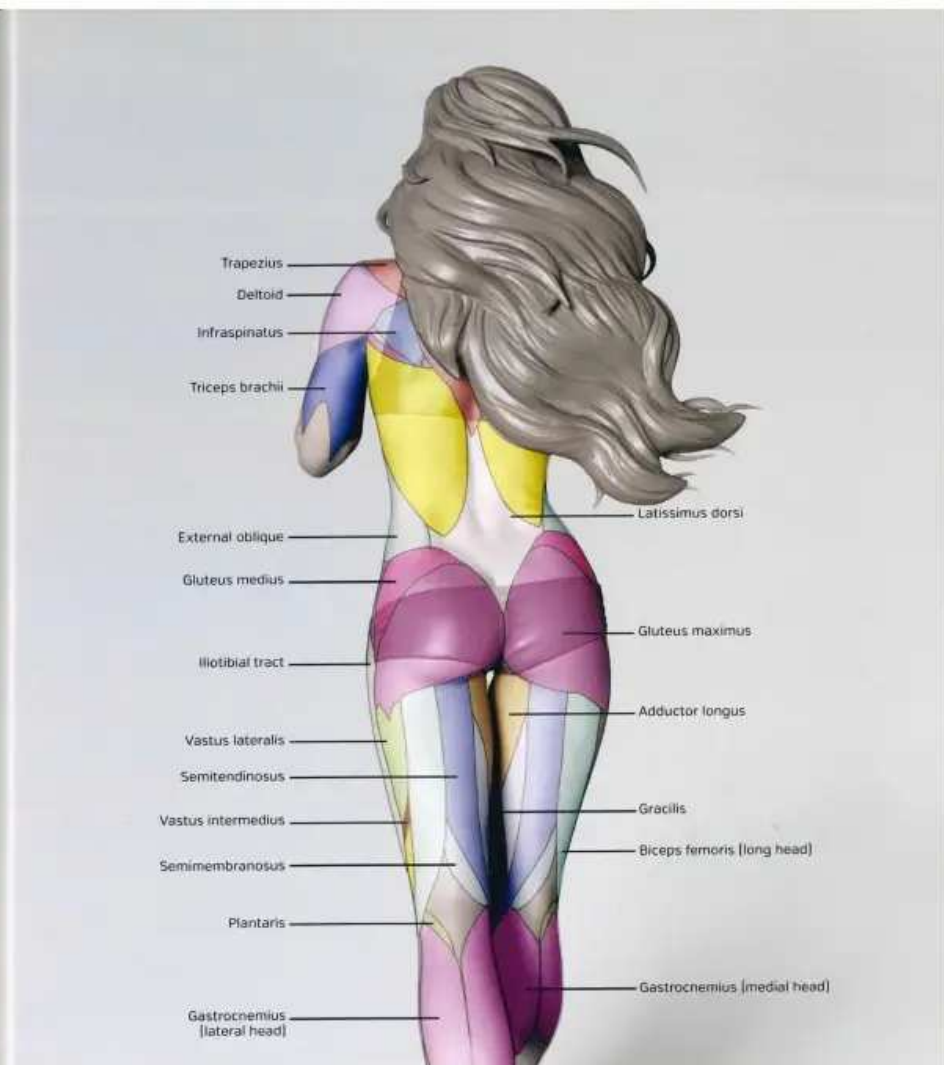




Gastrocnemius
Peroneus longus
Extensor digitorum longus
Tibialis anterior


Extensor digitorum longus
Peroneus longus


Extensor digitorum
Deltoid
Biceps brachii
Brachialis
Triceps brachii (lateral head)
Latissimus dorsi
Serratus anterior
Gluteus medius
Iliotibial tract
Gracilis
Rectus femoris
Vastus lateralis
Biceps femoris (long head)
Biceps femoris (short head)
Soleus
Peroneus longus
Extensor digitorum longus
Extensor hallucis longus
Sternohyoid
Sternocleidomastoid
Pectoralis major
Flexor digitorum superficialis
Extensor carpi ulnaris
Flexor carpi ulnaris
Anconeus
Rectus abdominis
External oblique
Tensor fasciae latae
Adductor longus
Sartorius
Vastus medialis
Gastrocnemius (medial head)
Tibialis anterior


Trapezius
Deltoid
Infraspinatus
Triceps brachii
External oblique
Gluteus medius
Iliotibial tract
Vastus lateralis
Semitendinosus
Vastus intermedius
Semimembranosus
Plantaris
Gastrocnemius (lateral head)
Latissimus dorsi
Gluteus maximus
Adductor longus
Gracilis
Biceps femoris (long head)
Gastrocnemius (medial head)